

3.0 SITE CHARACTERIZATION

3.1 Introduction

This section presents the Site Conceptual Model, which describes the nature and extent of contamination in the potential source areas. This information is used to assess the impact of the source areas on groundwater quality, based on contaminant transport modeling (Section 5.0). As discussed previously, one of the objectives of OU-2 remediation is to facilitate the OU-1 groundwater remedy, or decrease the time it takes to clean up the aquifer (i.e., meet aquifer restoration standards). In order to model the impact of the source areas on groundwater quality (see Section 5), it is first necessary to have an understanding of the site characterization, which is based on interpretation of 1) the site geology and hydrogeology, and 2) contaminant distribution in groundwater and the potential source areas.

Section 3.1 summarizes the results of investigations of the geology and hydrogeology at the Site. This information includes the identification and characterization of the water-bearing units and aquifers associated with the Site. Geologic properties (i.e., types, extent and thickness of geologic units) and hydraulic properties (i.e., groundwater conductivity, flow direction and discharge) are discussed. This information is used to evaluate the influence of the geology and hydrogeology on the release and movement of contaminants from the potential sources and in groundwater.

Due to the complexity of the site (as evidenced by the number of potential source areas, the number and variety of contaminants present, and the size of the sample database), it is not practical to characterize and model the fate and transport of every contaminant within each potential source area. Therefore, characterization of the nature and extent of contamination in the source areas and groundwater is based on evaluation of a focused list of nine (9) sitewide organic chemicals and three (3) source area specific inorganic chemicals. These twelve (12) chemicals are called “Chemicals of Concern” (COCs). The list of COCs identified for the OU-2 FS process and the rationale for their selection was presented in the “Chemicals of Concern Technical Memorandum” (Ciba 1999d) previously approved by EPA. These COCs, which were used to characterize the potential source areas, define the extent of contaminant mass loading to groundwater (both location and magnitude) and evaluate chemical fate and transport, are as follows:

Sitewide COCs

1,2,3-Trichloropropane

1,2,4-Trichlorobenzene

1,2-Dichlorobenzene

2-Chlorotoluene

Chlorobenzene

Naphthalene

Nitrobenzene

Tetrachloroethene

Trichloroethene

Source Area Specific COCs

Arsenic (Lime Sludge Disposal Area)

Lead (Backfilled Lagoon Area)

Mercury (Filtercake Disposal Area)

These chemicals represent the chemical mass and toxicity of site contaminants with respect to groundwater and the source areas, reflect a range of chemical mobilities and represent the major classes of contaminants associated with the Site.

Based on these COCs, the current three-dimensional spatial distribution of contaminants in groundwater, which represents the groundwater “plume,” is described in Section 3.2. The definition of the current groundwater plume is based on groundwater data collected over the past two years, 1997 and 1998. This data was collected during several groundwater investigations or monitoring programs, namely the OU-1 Long Term Monitoring Program, the Intrinsic Bioremediation Demonstration Study, the Supplementary Groundwater Sampling Program and the Groundwater Profiling Study.

Characterization of COCs within the individual source areas is presented in Section 3.3. The source characterization includes a statistical summary of the compiled data and a source area conceptual model for each potential source area. The characterization is based on the extensive historical database for the source areas. This includes data that was collected during the Source Control RI described in Section 2 as well as during several additional investigations conducted by Ciba under EPA oversight. These investigations include the NAPL Action Plan and the Supplemental Source Area Investigation.

The source area characterization data presented in Section 3.3 was then transformed into data sets to be used in the Source Block Model component of the Contaminant Transport Model (CTM). This process of transforming the characterization data into source blocks is described in Section 5.

3.2 Site Geology and Hydrogeology

3.2.1 SITE GEOLOGY

The site is located in the New Jersey Coastal Plain. The land surface depth for the site varies from as low as 40 feet Below Land Surface (BLS) in the vicinity of Toms River to over 60 feet BLS in other locations on the site. The upper 200 feet beneath the site is underlain by nine geologic layers comprised of unconsolidated sands, silts, and clays. The nine uppermost, recognized geologic members underlying the site, in descending order, are:

1. Upper Cohansey Member
2. Cohansey Yellow Clay Member
3. Primary Cohansey Member
4. Cohansey/Kirkwood Transitional Member
5. Lower Cohansey Member
6. Upper Kirkwood Member
7. Kirkwood No. 1 Member
8. Semi-Confining Unit (Primary Kirkwood)
9. Lower Sand Aquifer (Kirkwood No. 2 Sand)

Dissolved contaminants have leached from the source areas into portions of the upper five (5) geologic units (i.e., the Primary and Lower Cohansey Members). Units below the Lower Cohansey are uncontaminated. Geologic features of each of these units are discussed below.

3.2.1.1 Upper Cohansey Member

The Upper Cohansey Member overlies the Cohansey Yellow Clay Member. Where the clay unit is not present, the stratigraphic units that are correlative to the Upper Cohansey Member are considered part of the Primary Cohansey Member. The unit is generally described under Burmister Soils Classification identically to the Primary Cohansey Member. At some locations a perched water system is present. In conjunction with source areas, the perched water system can provide a mechanism for transport of dissolved contaminant of concern mass to lower geologic units.

3.2.1.2 Cohansey Yellow Clay Member

The Primary Cohansey Member is conformably overlain by an undulating clay layer known as the Cohansey Yellow Clay Member. The clay is discontinuous throughout the area of the site, but where present may function as an aquitard that locally controls the movement of perched groundwater or cause confining/semi-confining conditions within the Primary Cohansey Member. The unit is generally described under Burmister Soils Classification as follows:

- Yellow, tan, and dark grey to black, laminated CLAY & SILT to silty CLAY, soft to medium dense, thinly interbedded with orange to white, coarse to medium to fine-grained (cmf) SAND.

It should be noted that the formation thickness can include some thin sand/clay interfingering. Where this exists, the sand stringers may provide a pathway for dissolved contaminants in perched groundwater to move into and/or through the clay unit.

3.2.1.3 Primary Cohansey Member

The Primary Cohansey Member is a water-bearing unit. It is distinguished from the underlying Cohansey/Kirkwood Transitional Member and the overlying Cohansey Yellow Clay Member (where present) on the basis of its coarser grain size, its well-sorted character and the general absence of silt, clay, and organic matter. The unit is generally described under Burmister Soils Classification as follows:

- Dark grey to white, yellow to orange cmf SAND, trace Silt, trace medium to fine (mf) Gravel, well sorted, dense.

This aquifer contains a substantial mass of COCs.

3.2.1.4 Cohansey/Kirkwood Transitional Member

The upper surface of the Cohansey/Kirkwood Transitional Member occurs at elevations ranging from 18 to -34 feet msl across the site. The unit is distinguished from the underlying and overlying units by its significantly finer-grained character and its significant mica content. Mica is a distinctive mineral known for its inherent ability to impede vertical flow through flat-lying, mica-containing sediments. The fine grained nature of the Cohansey/Kirkwood Transitional Member relative to the more coarse-grained nature of the Primary Cohansey and its high mica content results in a substantial hydraulic conductivity differential between the units. The hydraulic conductivity differential is approximately 2 orders of magnitude. This is sufficiently large enough to characterize the Cohansey/Kirkwood Transitional

Member as an aquitard with respect to the downward movement of contaminant of concern mass in the vicinity of the source areas.

Toward the north, the Cohansey/Kirkwood Transitional member becomes increasingly coarser-grained. Also toward the north, the thickness of the unit begins to decrease until it eventually disappears entirely in the extreme northern portion of the site. Toward the south, the thickness of the underlying Lower Cohansey Member begins to decrease until it eventually disappears entirely. At this point the Cohansey/Kirkwood Transitional Member grades into and is indistinguishable from the Upper Kirkwood Member. The data indicate that the unit ranges from 0 to 32 feet thick. The unit is generally described under Burmister Soils Classification as follows:

- Dark grey to dark brown, yellow to orange fine (f) SAND and SILT to f SAND, some Silt, micaceous, loose (soft).

As stated previously, dissolved COC mass has penetrated into this unit and reached the lower Cohansey Member.

3.2.1.5 Lower Cohansey Member

The Lower Cohansey is one of the water-bearing units beneath the site. In the northern portion of the site, the overlying Cohansey/Kirkwood Transitional Member thins and eventually disappears entirely in the extreme northern portion of the site. Where this occurs, the Lower Cohansey and Primary Cohansey Members are undifferentiated. In the southern portion of the site, the Lower Cohansey Member thins and eventually grades into sediments that are indistinguishable from the underlying Upper Kirkwood and overlying Cohansey/Kirkwood Transitional Members.

In the southern portion of the site, where the Lower Cohansey Member is defined, the upper surface ranges from -21 to -57 feet (msl). The existing data indicate that the unit ranges from 0 to 39 feet thick. The unit is generally described under Burmister Soils Classification as follows:

- Light grey, brown, yellow, and white cmf SAND; trace to little silt, trace fine (f) Gravel; well sorted, dense.

Dissolved COC mass has leached into this unit.

3.2.1.6 Upper Kirkwood Member

The Upper Kirkwood Member is a relatively fine-grained unit that behaves as an aquitard at the site. In the southern portion of the site the overlying Lower Cohansey Member grades downward into sediments indistinguishable from the Kirkwood sediments. In this area, the Upper Kirkwood Member is directly overlain by the Cohansey/composited unit contains discontinuous beds of fine sands that are lithologically similar to sands of the Kirkwood No. 1 Member, although somewhat finer-grained.

In the northern portion of the site, where the Upper Kirkwood Member is defined, the upper surface ranges from -33 to -62 feet (msl). The existing data indicate that the unit ranges from 24 to 39 feet thick. The unit is generally described under Burmister Soils Classification as follows:

- Dark grey to dark brown f SAND and SILT to f SAND, some Silt; with intervals of dark grey-brown SILT & CLAY to clayey SILT, micaceous, lignitic, with frequent peat fragments, loose (soft) to medium dense (stiff).

This unit is uncontaminated.

3.2.1.7 Kirkwood No. 1 Member

The upper surface of the Kirkwood No. 1 Member occurs at elevations of -64 to -101 feet (msl) across the site. The existing data indicate that the unit ranges from 10 to 26 feet thick under the site. The unit is a clean, well-sorted water-bearing sand that has a gradational contact with, and conformably overlies, the SEMI-CONFINING UNIT. The unit is typically coarser-grained and better sorted than the underlying and overlying units. The unit is generally described under Burmister Soils Classification as follows:

- Light grey to brown mf SAND, trace to little Silt, well sorted, slightly micaceous, occasionally interbedded with layers of organic Silt, very dense.

This unit is uncontaminated.

3.2.1.8 Semi-Confining Unit

The upper surface of the SEMI-CONFINING UNIT occurs at elevations of -82 to -115 feet (msl) across the site. The existing data indicate that the unit ranges from 38 to 53 feet thick under the site. The unit behaves as an aquitard and is distinguished from the underlying and overlying units by its greater silt content as well as organic matter content and abundance of mica. The unit is generally described under Burmister Soils Classification as follows:

- Dark grey to dark brown SILT, little f Sand to f Sand and SILT; micaceous, lignitic, with frequent peat and wood fragments, loose (soft) to medium dense (stiff).

This unit is uncontaminated.

3.2.1.9 Lower Sand Aquifer

The upper surface of the LOWER SAND AQUIFER occurs at elevations of -131 to -153 feet (msl) across the site. The existing data indicate that the unit ranges from 4 to 11 feet thick under the site. The unit is a water-bearing unit distinguished from the underlying and overlying units by its well-sorted character and by its significantly lower silt and clay content. The unit is generally described under Burmister Soils Classification as follows:

- Light grey to brown cmf SAND, trace to little Silt, well sorted, with green streaks of SILT.

This unit is uncontaminated.

3.2.2 SITE HYDROGEOLOGY

EPA has divided the geologic units present beneath the site into two hydrostratigraphic subdivisions: the Upper Sand Aquifer and the Lower Sand Aquifer. These two subdivisions are separated by the Semi-Confining Unit. Therefore, the Upper Sand Aquifer consists of the Upper Cohansey Sand Member through the Kirkwood No. 1 Sand Member, while the Lower Sand Aquifer consists of the Kirkwood No. 2 Sand Member.

Within the Upper Sand Aquifer, the Cohansey Yellow Clay Member can create perched water conditions. Where this exists, the perched aquifer is referred to as the Upper Cohansey aquifer. Based on the hydraulic conductivity of the Upper Cohansey Sand Member estimated from pump tests and the hydraulic gradient across the site, the groundwater velocity is expected to be one (1) to two (2) feet per day. It is recognized that the surface of the clay is irregular and that in some areas, interfingering of sand stringers within the clay unit may provide pathways for the downward migration of groundwater. These features influence the flow of the perched groundwater aquifer on a very local scale.

The regional groundwater aquifer also exists within the Upper Sand Aquifer. This is referred to as the Primary Cohansey aquifer in the vicinity of the site. The hydraulic conductivity of the Primary Cohansey Sand Member is estimated from pump tests to result in groundwater velocities slightly lower than

groundwater velocities in the Upper Cohansey Sand Member (1 to 2 feet per day). This is because although hydraulic conductivities are essentially equivalent, hydraulic gradients in the Upper Cohansey Sand Member are slightly higher, thereby resulting in slightly higher groundwater velocities. Storativity (i.e., volume of water released from storage per unit change in head per unit area) of the Primary Cohansey aquifer varies from 0.003 to 0.18, where the lower value reflects local confined conditions due to the presence of an overlying clay unit.

Groundwater flow within the Primary Cohansey aquifer is principally horizontal, while vertical flow becomes increasingly important in aquitards and near local discharge points. In the Primary Cohansey aquifer, groundwater west of the Toms River flows mainly to the east and southeast. East of the Toms River, flow directions are toward the west and southwest (Eckenfelder 1992). The most prominent feature of groundwater flow within the aquifer is that groundwater discharges along the Toms River floodplain and eventually into the River. While lower permeability lenses exist within the aquifer, these do not appear to impact the overall flow pattern across the site.

The Lower Cohansey Sand Member also exists within the Upper Sand Aquifer. The Lower Cohansey Sand Member was determined to have a somewhat lower hydraulic conductivity (and lower groundwater velocity) than the overlying aquifers. This aquifer is referred to as the Lower Cohansey aquifer in the vicinity of the site. The storativity (i.e., volume of water released from storage per unit change in head per unit area) is low (2×10^{-4}) due to the confining effects of the Cohansey/Kirkwood Transitional Member. Groundwater flow within the Lower Cohansey aquifer reflects that of the Primary Cohansey aquifer.

Hydraulic information about the Lower Sand Aquifer is derived primarily from slug tests (Eckenfelder 1992). The hydraulic conductivity of this member is estimated to result in groundwater velocities less than 1 foot per day. The storativity is not known. Groundwater flow within the Lower Sand Aquifer is significantly different from that in the Upper Sand Aquifer. Groundwater flow is towards the east and southeast, and the Toms River exerts little influence on the flow patterns within the aquifer. The Semi-Confining Unit appears to effectively isolate the Lower Sand Aquifer from the Upper Sand Aquifer.

3.3 Aquifer Characterization

The general, three-dimensional spatial distribution of contaminants (plumes) in the groundwater affected by the Site is discussed in this subsection. Plume characterization information is essential for 1)

calibrating the Contaminant Transport Model (CTM); 2) determining the impact of sources on groundwater quality; 3) defining the initial condition in calculating the time of compliance (TOC); and 4) optimizing the groundwater extraction and recharge system (GERs) to facilitate aquifer restoration.

3.3.1 DATA USED IN AQUIFER CHARACTERIZATION

A large amount of data has been collected and interpreted since the late 1980s in order to understand the contaminant distribution at the Site. Because the groundwater contaminant distribution (plume) has evolved over the years, the definition of the current plume makes use of data collected over the previous two years, 1997 and 1998. However, insight with respect to contaminant distribution at the Site using earlier data has helped with the current plume definition. In fact, historical groundwater quality data was used in the calibration of the CTM.

The groundwater quality data used in the development of the current interpretation of groundwater contaminant distribution were obtained from several groundwater investigations or monitoring programs, namely the Site-Wide Monitoring Program, the Intrinsic Bioremediation Demonstration Study, the Supplementary Groundwater Sampling Program and the Groundwater Profiling Study. The scope of each of these programs is summarized below.

The Sitewide Monitoring Program is part of the OU-1 Long-term Monitoring Program (see Section 2.3.1.5). This groundwater monitoring program requires sampling of 120 sitewide monitoring wells on a semiannual basis for volatile organic compounds (VOCs). The data used for the aquifer characterization reflects sampling conducted in 1997 and 1998 (i.e., four (4) sampling events).

The scope of work for the Intrinsic Bioremediation Demonstration Study was described in the study work plan (Ciba 1998h). Under this study, two (2) rounds of groundwater samples were collected from approximately eighty (80) groundwater monitoring wells in late 1997 through 1998 and were analyzed for VOCs and semivolatile organic compounds (SVOCs). The results of this study are provided in Appendix D-3.

Another groundwater monitoring well sampling and analysis program was referred to as the Supplementary Groundwater Sampling Program. The objective of this program was to collect additional groundwater samples to aid in the CTM calibration effort. Samples were collected from various

monitoring wells and the forty-three (43) GERS extraction wells. These samples were also collected from late 1997 through 1998 and were analyzed for VOCs and SVOCs.

Groundwater profile data collected in 1998 and 1999 were used to supplement the groundwater monitoring well data for characterizing the distribution of groundwater contaminants described in this section. Groundwater profiling is a relatively new technique that allows samples of water or soil to be obtained at discrete depth intervals during advancement of a probe through the soil or aquifer, thus allowing many samples to be taken per depth profile. This allows the determination of parameters at small depth intervals, so that the vertical distribution of parameters becomes known in detail. A total of fifty-four (54) groundwater profiles, comprising a total of 3,775 feet, were completed on the Site.

During the profiling work, a field laboratory analyzed 550 groundwater samples for target VOCs. Because the analytical method was different from that normally performed on groundwater samples collected at the Site and because samples were collected differently, the data from the profiling work were treated as screening level data. Nevertheless, they were important in developing the plume interpretations. The results of the groundwater profiling investigation are provided in Appendix B-3.

The sample locations from these groundwater investigations and monitoring programs are provided in Figures 3-1 through 3-5, by layer. These figures are provided at the end of Section 3.2. The definitions of the layers are provided below.

3.3.2 PROCEDURE FOR INTERPOLATION OF DATA AND GENERATION OF GROUNDWATER CONCENTRATION DISTRIBUTIONS

The interpretation of the groundwater contaminant distribution associated with the Site is quasi-three dimensional. The first step in the interpretation process was to divide the groundwater quality data in the Upper Sand Aquifer into five (5) layers: 1) top of the Primary Cohansey Member; 2) middle of the Primary Cohansey Member; 3) bottom of the Primary Cohansey Member; 4) the Lower Cohansey Member; and 5) the Kirkwood Number 1 Sand. The Primary Cohansey Member was divided into top, middle and bottom layers because of the significant saturated thickness of the member. Because the Lower Cohansey is a relatively thin unit, it was not subdivided into separate layers.

Aquitard units are excluded from this discussion and groundwater quality data interpretation. These include the Cohansey-Kirkwood Transition Zone and the Upper Kirkwood Members of the Upper Aquifer. In these aquitard units, groundwater flow, and thus contaminant transport, is slower than in the

aquifers and tends to be more vertical than for the overlying or underlying aquifer units. The perched groundwater flow system is also excluded from this analysis, because the perched system is local to source areas and is not a site-wide condition.

In the database, monitoring wells have been assigned to a layer based on their screen intervals. In those few cases in which the screen intervals penetrate two layers, the concentration data were assigned to both layers. Groundwater profile samples were assigned to similar layers, and concentrations for samples assigned to each depth interval were averaged to generate the concentrations used to interpolate groundwater contaminant concentrations.

The second step in the interpretation process was to interpolate the concentrations in each layer using an inverse distance approach, using entec software. The interpolation was constrained by plume boundary points representing the edge of the plume, based on professional judgment regarding the distribution of the plume and groundwater flow directions. The lowest concentration contour for each chemical of concern (COC) used in map preparation was the aquifer restoration standard (ESD Table 2) for that compound. If the COC was not an ESD Table 2 parameter (i.e., naphthalene), then the more stringent of the federal or state maximum contaminant level (MCL) was used.

Ratios of groundwater concentration as compared to the aquifer restoration standards for each COC were also developed. These ratios were used to determine the overall extent of the plume boundaries and to identify the COCs near sources that contribute the “important” mass, from a remediation perspective. The process of developing the contours was similar to that described above except that the contours represent the highest chemical concentration to aquifer restoration standard ratio for the COCs at a particular monitoring or groundwater profile location. For example, if the concentration to standard ratio for chlorobenzene was five (5) and that for trichloroethene was ten (10), then the contours would be based on the ratio of ten (10). The compounds with the highest concentration to standard ratios are identified at each monitoring or groundwater profile location on the contours, along with the ratio values.

The third step in the interpretation process was one of contour “smoothing”, performed manually. The basis of this process was professional judgment, which further considers what is known about the groundwater flow at the Site, source area locations, and contaminant transport processes. Consistency among the different compounds and relationships among the different layers that are intuitive, while honoring the data, were basic objectives of this step of the interpretation process.

Contour maps of the groundwater contaminant distribution for Primary and Lower Cohansey layers of the Upper Sand Aquifer are presented in Figures 3-6 to 3-49 at the end of Section 3.2. For each layer, separate contour maps are provided based on the individual organic COC concentrations and the concentration to standard ratios (Figures 3-6 through 3-45). The three inorganic COCs are included together on the same maps (Figures 3-46 through Figure 3-49). These contour maps are discussed in the next section.

There are relatively few inorganic COC detects or exceedances in the Primary Cohansey. In the top of the unit, there were only three (3) exceedances for lead out of eighteen locations, one of which was within the range of background concentrations (Figure 3-36). The other two exceedances were located in the vicinity of the Backfilled Lagoon Area. Also in the top layer, there is only one, minor mercury exceedance of 2.9 ppb versus a criterion of 2.0 ppb. In the middle of the Primary Cohansey, there was a single exceedance out of 25 locations of any of the inorganic COCs (3-47), while there was a single exceedance out of 59 locations at the bottom of the unit (3-48). Both of those were for lead. There are no exceedances of arsenic in the Primary Cohansey Member.

3.3.3 GENERAL DESCRIPTION OF GROUNDWATER CONTAMINANT DISTRIBUTION

In general, the contaminant distribution at the Site is described as occurring in two plumes, referred to as the north and south plumes. The north plume refers to groundwater contamination occurring north and east of the former Equalization Basins, while the south plume refers to contaminated groundwater east and south of the Drum Disposal Area. This general distribution is apparent on Figure 3-6, for example. The orientations of the plume axes are consistent with the directions of groundwater flow in each part of the Site, although portions of the plume also reflect past flow conditions. Historical groundwater pumping conditions at the Site have affected the three-dimensional distribution of contaminants in the aquifer. For example, past groundwater flow conditions were impacted by operation of the production wells and original seven (7) purge wells. Current flow conditions are impacted by the current groundwater extraction (GERs) wells. This pumping history is taken into consideration in the evaluation of contaminant fate and transport (see Section 5.0).

Figures 3-6 through 3-45 provide the interpolation of groundwater concentrations of individual organic COCs or the ratios of concentration to standard, by layer. Figures 3-15, 3-25, 3-35 and 3-45 are contours of the maximum ratios of individual organic compound concentrations versus the aquifer restoration

standard for that compound, as described in Section 3.2.1. On most of the figures for the Primary Cohansey Member layers, the two-plume characteristic of the contaminant distribution is apparent.

In the Lower Cohansey Member, the plume is confined to the north. Little contamination of the Lower Cohansey Member is indicated in the south plume for two reasons: 1) contaminant levels in the Lower Cohansey in the south are low, where it exists; and 2) in the southern portion of the site, the Lower Cohansey Member thins and eventually grades into sediments that are indistinguishable from the underlying Upper Kirkwood and overlying Cohansey/Kirkwood Transitional Members. Both of these Members are aquitard units, consisting of fine-grained material characterized by lower permeability. The discussion that follows describes features of the groundwater contaminant distribution associated with the Site.

In the top of the Primary Cohansey Member, the two plume character of the site-related groundwater contamination is readily apparent for chlorobenzene (Figure 3-6), 2-chlorotoluene (Figure 3-7), 1,2-dichlorobenzene (Figure 3-8), 1,2,4-trichlorobenzene (Figure 3-9), trichloroethene (Figure 3-10), tetrachloroethene (Figure 3-11) and trichloropropane (Figure 3-12). The two-plume characteristic of contaminant distribution at the Site is also apparent in the bottom layer of the Primary Cohansey Member for chlorobenzene (Figure 3-26), 1,2,4-trichlorobenzene (Figure 3-29), trichloroethene (Figure 3-30), tetrachloroethene (Figure 3-31) and 1,2,3-trichloropropane (Figure 3-32). Several compounds, such as 2-chlorotoluene and 1,2-dichlorobenzene, are strongly associated with the north plume and are not at all or weakly associated with the south plume.

Another major feature of the Primary Cohansey Member is that concentrations greater than 100 parts per billion (ppb) for most compounds are generally consistent with their origination from the known major source areas. The relationship between concentration distribution and source areas is stronger for the top of the Primary Cohansey Member than for the deeper layers, with few exceptions. This is because as dissolved compounds migrate, they move farther downgradient from the source area and deeper into the unit in response to downward hydraulic gradients. Thus, concentrations of COCs in the lower layers may have migrated far from the sources, especially in downgradient locations within the plume. As a rule of thumb, the horizontal component of flow is toward the Toms River, so that downgradient portions of the plume are closer to the river.

3.3.3.1 North Plume

3.3.3.1.1 Primary Cohansey Member

In examining COC distributions, each groundwater plume can be distinguished by areas proximal to sources and those that are near the plume boundaries. In the vicinity of the source areas, different compounds have the highest concentrations relative to those with highest concentrations in downgradient parts of the plume. There are several reasons for this observation, including 1) the history of mass flux from sources; and 2) difference in the fate characteristics of the different compounds (i.e., some compounds degrade more easily than others do). Regarding mass flux, compounds that are located farther downgradient from their sources were released earlier in time than those located proximal to sources. In earlier times, compounds were leached at different rates to the groundwater than they were in later times.

In general, the locations of the boundaries (edges) of the north plume are largely controlled by trichloroethene and chlorobenzene (Figures 3-15, 3-25, and 3-35). Closer examination of those figures reveals that trichloroethene is a more important determinant of the plume boundary at the bottom while chlorobenzene is more important in the shallower parts of the Primary Cohansey Member. These figures also identify those COCs proximal to the sources that are likely to control source remediation, considering only the groundwater concentration data relative to their respective aquifer restoration standards. Examples of organic COCs associated with specific source areas are illustrated below.

- Equalization Basins: 2-chlorotoluene, 1,2,4-trichlorobenzene and tetrachloroethene
- Underground Storage Tank (UST)/Building 108 Area: 1,2,4-trichlorobenzene, 2-chlorotoluene, chlorobenzene and trichloroethene
- Former South Dye Area: 2-chlorotoluene, trichloroethene, chlorobenzene and 1,2,4-trichlorobenzene.
- Backfilled Lagoon Area: chlorobenzene, trichloroethene and 1,2,4-trichlorobenzene
- Borrow Compactor Area: trichloroethene

When compared to the top of the Primary Cohansey, as is expected, the association of particular compounds to individual source areas in the deeper layers becomes more ambiguous. As compounds migrate away from source zones, they move downgradient and generally downward, in response to the hydraulic gradient. Source zones are located such that contaminated groundwater from more upgradient sources, such as the Former South Dye Area, pass under or near more downgradient sources, such as the

Former Building 108/Underground Storage Tank Area and the Backfilled Lagoon Areas. This makes it difficult, based on evaluation of the COC distribution in groundwater, to separate the contributions of each source. Local changes in groundwater flow directions in the past and the effects of dispersion contribute to the difficulty is separating the contributions of different source areas to concentrations in the aquifer. As stated previously, groundwater flow directions were affected by production well, purge well and GERS well pumping activities. The CTM is used to determine the relative contribution of the potential sources of groundwater contamination, as presented in Appendix C of this report.

Comparison of Figure 3-16 with Figure 3-6, which describes the distribution of chlorobenzene in the middle and top of the Primary Cohansey Member, respectively, illustrates salient features of groundwater transport from the source areas. In the north plume, the relatively high concentration zones are located further downgradient in the middle layer than in the top layer. As another example, compare Figure 3-26 with Figure 3-16, which presents the distribution of chlorobenzene in the bottom and middle of the Primary Cohansey member, respectively. This comparison demonstrates rather clearly the effect of contaminant transport on the distribution of this compound. For example, the 1,000 ppb contour in the north plume has shifted to the east and to the north relative to the corresponding contour in the middle layer, consistent with known features of groundwater flow.

There were no exceedances observed for arsenic and mercury in the Lower Cohansey Member (Figure 3-49). Only two exceedances for lead, out of a total of 37 locations, were observed in the Lower Cohansey Member. One was within the range of background values and is not related to the site. The second location has a concentration at the upper end of the background concentration range. The upper end of the range is 25 ppb, versus the measured value of 26 ppb.

3.3.3.1.2 Lower Cohansey Member

The organic COC concentration and concentration to standard ratio distribution contours in the Lower Cohansey Member are illustrated in Figures 3-36 through 3-45. Chlorobenzene, trichloroethene, tetrachloroethene and 1,2,3-trichloropropane are widely distributed in this aquifer unit, underlying most, if not all, of the footprint of the Primary Cohansey Member north plume. Trichloroethene is the compound that determines the overall boundary of the Lower Cohansey Member plume (Figure 3-45).

Due to the depth of the Lower Cohansey Member below the source areas, it is frequently difficult to directly relate concentrations of COCs to individual sources. However, based on inspection of Figure 3-45, two compounds in the Lower Cohansey can be related to source areas. Chlorobenzene is associated

with the Equalization Basins. Trichloroethene underlies the Building 108/UST Area, although groundwater flow patterns facilitated by past production well pumping could account for this occurrence originating from the Equalization Basins. This past pumping is known to have imparted a strong northward component of flow to north plume groundwater. Although trichloroethene concentrations underlie the more downgradient sources, such as the Backfilled Lagoon Area, an upgradient source for these occurrences cannot be ruled out, by inspection of the maps.

In addition to chlorobenzene, other COCs found in the Lower Cohansey which are associated with the Equalization Basins are 2-chlorotoluene (Figure 3-37), 1,2,4-trichlorobenzene (Figure 3-38), 1,2-dichlorobenzene (Figure 3-39), tetrachloroethene (Figure 3-41), nitrobenzene (Figure 3-43) and naphthalene (Figure 3-44). In addition to trichloroethene, other COCs that underlie the Former Building 108/Underground Storage Tank Area and are found in the Lower Cohansey are 1,2,3-trichloropropane (Figure 3-42) and nitrobenzene (Figure 3-43).

Concentrations of chlorobenzene in excess of one (1) part per million (ppm) are farther downgradient and less extensive in the Lower Cohansey Member than for the lower layer in the Primary Cohansey Member. This is consistent with advective transport of dissolved phase chlorobenzene through the Cohansey-Kirkwood transition unit, which separates those two aquifer layers. The distribution of 1,2,4 trichlorobenzene can be explained in the same way (Figure 3-38).

The distributions of trichloroethene, tetrachloroethene and 1,2,3-trichloropropane in the Lower Cohansey are illustrated in Figures 3-40, 3-41 and 3-42, respectively. Aqueous phase transport or migration with a NAPL through the Cohansey-Kirkwood Transition Unit can explain the occurrence of these compounds in the Lower Cohansey. Downward migration of these compounds in the aqueous phase would have been facilitated by former production well pumping.

It should be noted that aquifer units below the Lower Cohansey, including the Kirkwood Number 1 Sand Member of the Upper Sand Aquifer, are uncontaminated with respect to the organic COCs (i.e., do not have confirmed exceedances of aquifer restoration standards), and thus contour maps were not applicable. Only one exceedance for an inorganic COC (lead) was noted in the Kirkwood Number 1 Sand, out of a total of 35 locations, but it was within the range of background groundwater concentrations.

3.3.3.1.3 Kirkwood Number 1 Member

As stated previously, in the Kirkwood Number 1 Sand Member of the Upper Sand Aquifer, there are no confirmed exceedances of aquifer restoration standards or background concentrations (inorganics) for the COCs. This defines the limit of the vertical distribution of the COCs in the north plume.

3.3.3.2 South Plume

3.3.3.2.1 Primary Cohansey Member:

In general, the locations of the boundaries (edges) of the south plume are largely controlled by trichloroethene, tetrachloroethene and, to a lesser extent, chlorobenzene (Figures 3-15, 3-25, and 3-35). All three compounds are important in determining the boundary throughout the thickness of the Primary Cohansey Member.

Figures 3-15, 3-25 and 3-35 also identify those compounds proximal to the sources that are likely to control source remediation, considering only the groundwater concentration data relative to their respective aquifer restoration. Such “control” compounds associated with the Filtercake Disposal Area are 2-chlorotoluene, chlorobenzene and tetrachloroethene. For the Drum Disposal Area and Standpipe Burner Area, the corresponding compounds are 2-chlorotoluene, chlorobenzene, trichloroethene and tetrachloroethene. Compounds that are apparently associated with the Lime Sludge Disposal Area have been explained as having migrated as dissolved constituents from the Drum Disposal Area and Standpipe Burner Area within a locally correlated sand lense (see Appendix B-3).

As compounds migrate away from source zones, they move downgradient and generally downward, in response to the hydraulic gradient. Source zones within each plume are located such that contaminated groundwater from more upgradient sources, such as the Drum Disposal Area and Standpipe Burner Area, pass under or near more downgradient sources, such as the Filtercake Disposal Area, so that it is difficult, upon inspection, to separate the contributions of each. Local changes in groundwater flow directions in the past and the effects of dispersion also contribute to the difficulty in separating the contributions of different source areas to concentrations in this and lower layers of the aquifer. Groundwater flow directions in the south plume were also affected by production well, purge well and GERS well pumping activities. The discussion of the CTM (Section 5.0 and Appendix C) provides a more detailed understanding of the evolution of the current plume.

COC distributions in the different layers in the Primary Cohansey Member illustrate the expected pattern of downward and downgradient migration of contaminants. For example, compare the distribution of chlorobenzene between the top (Figure 3-6) and bottom (Figure 3-26) layers of the Primary Cohansey Member. In the bottom layer, the 1,000 ppb and 100 ppb contours have migrated to the east, towards the Toms River, from the vicinity of the Filtercake Disposal Area, as is expected. A similar pattern can be discerned for trichloroethene in Figure 3-10 versus Figure 3-30 and for tetrachloroethene in Figure 3-11 versus Figure 3-31.

2-Chlorotoluene and nitrobenzene are readily susceptible to biodegradation. This expectation is supported by the observation that their concentrations exceed 100 ppb only in one location within the footprint of the Drum Disposal Area, but occur at much lower concentrations everywhere else in the south plume. Outside the footprint of the Drum Disposal Area, nitrobenzene is generally non-detect.

There are no observed confirmed exceedances of inorganic COCs in the south plume Primary Cohansey Member (Figures 3-46 through 3-48).

3.3.3.2.2 Lower Cohansey Member

The organic COC distributions in the Lower Cohansey Member are illustrated in Figures 3-36 through 3-45. Figure 3-49 illustrates the inorganic COC distributions in the Lower Cohansey Member. In the Lower Cohansey, COC exceedances of the restoration standards are not associated with the south plume for any of the COCs for reasons indicated above in Section 3.2.2.

3.3.3.2.3 Kirkwood Number 1 Member:

As stated previously, in the Kirkwood Number 1 Sand Member of the Upper Sand Aquifer, there are no confirmed exceedances of aquifer restoration standards or background levels (inorganics) for COCs. This defines the limit of the vertical distribution of the COCs in the south plume.

3.3.4 OVERALL CONCLUSIONS OF GROUNDWATER CONTAMINANT DISTRIBUTION

The distribution of organic COCs in the groundwater at the Site is largely consistent with the current understanding of the source areas, the groundwater flow conditions at the Site and the effects of contaminant fate and transport. The locations of highest concentrations of many of the organic COCs in the groundwater are close to the major source areas, especially in the top layer of the Primary Cohansey Member of the Upper Sand Aquifer. These are the Equalization Basins, the Former South Dye Area and

the Former Building 108/Underground Storage Tank Area in the north plume and the Drum Disposal Area, Standpipe Burner Area and Filtercake Disposal Area in the south plume. Among inorganic COCs in groundwater, mercury concentrations in the Primary Cohansey appear to be associated with the former EQ Basins and lead appears to be associated with the Backfilled Lagoon Area.

The current understanding of the distribution of organic COCs is illustrated in Figures 3-6 to 3-45. The information is useful in identifying the source areas that are major contributors to groundwater contamination at the site. This data, along with the historical groundwater quality data, were used in the calibration of the CTM (Section 5.0 and Appendix C). Understanding the groundwater contaminant distributions at the Site is also important for the future optimization of the GERS to facilitate aquifer restoration.

FIGURE 3-1
TOP OF THE PRIMARY COHANSEY
Plume Characterization Sample Locations

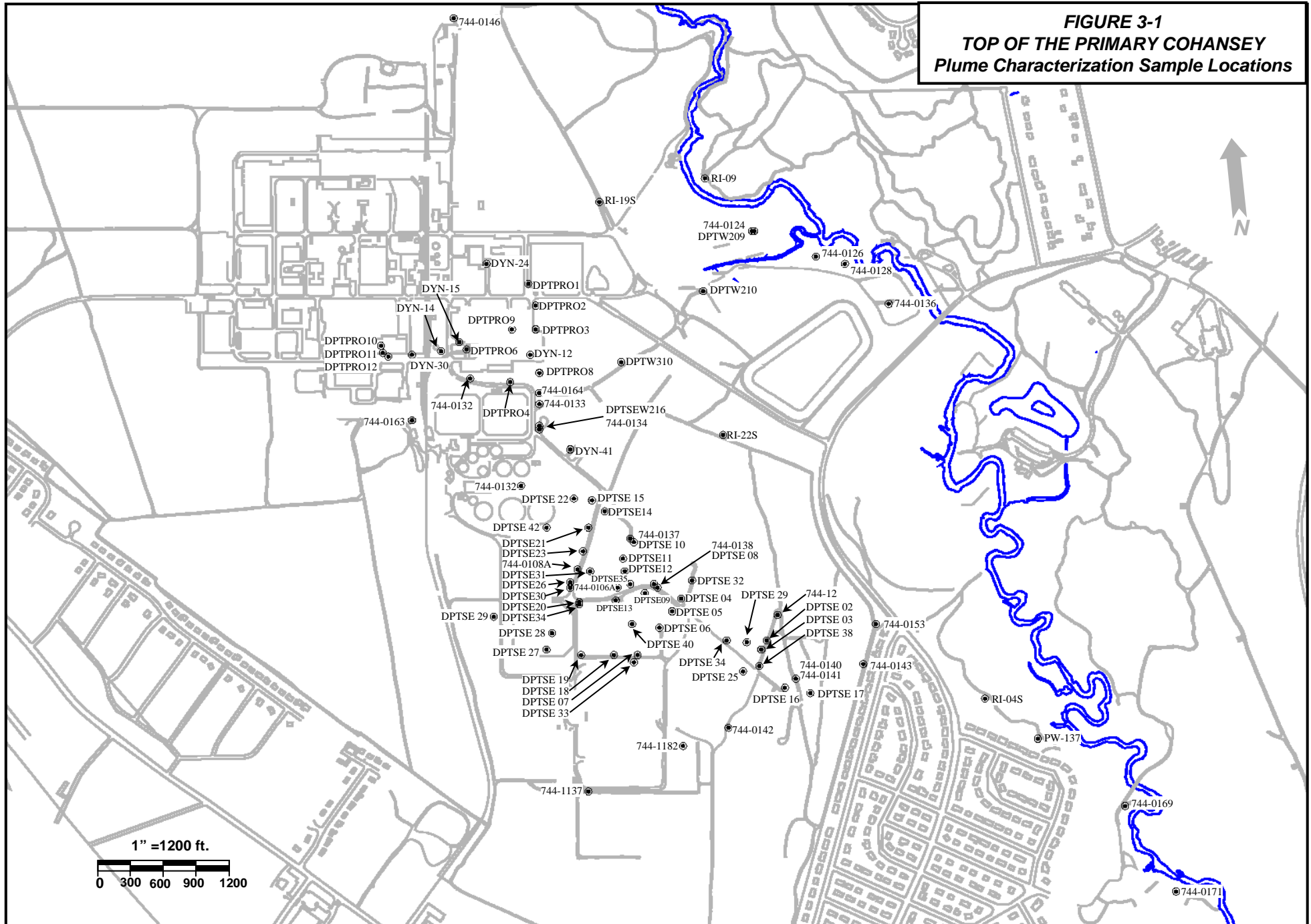


FIGURE 3-2
MIDDLE OF THE PRIMARY COHANSEY
Plume Characterization Sample Locations

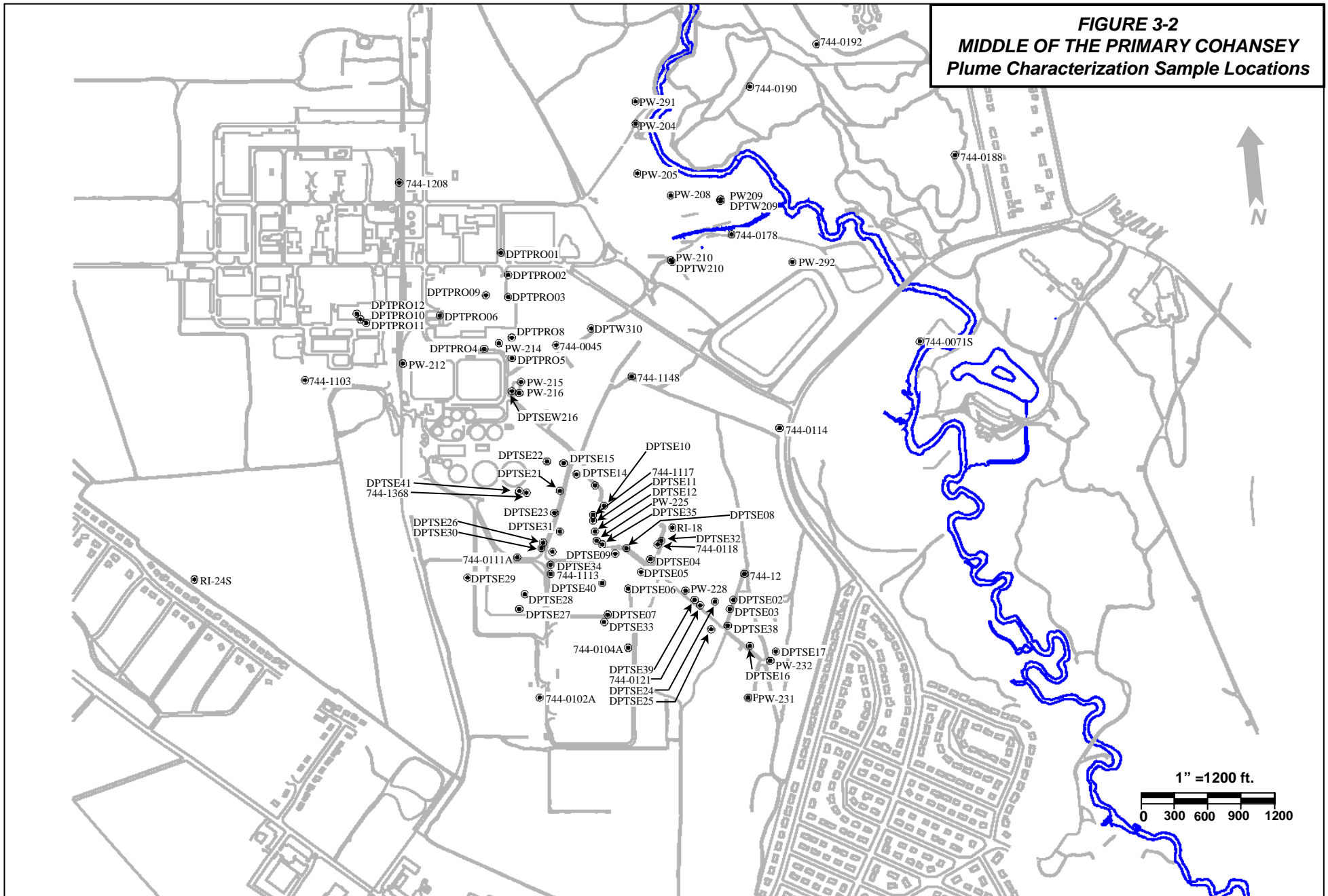
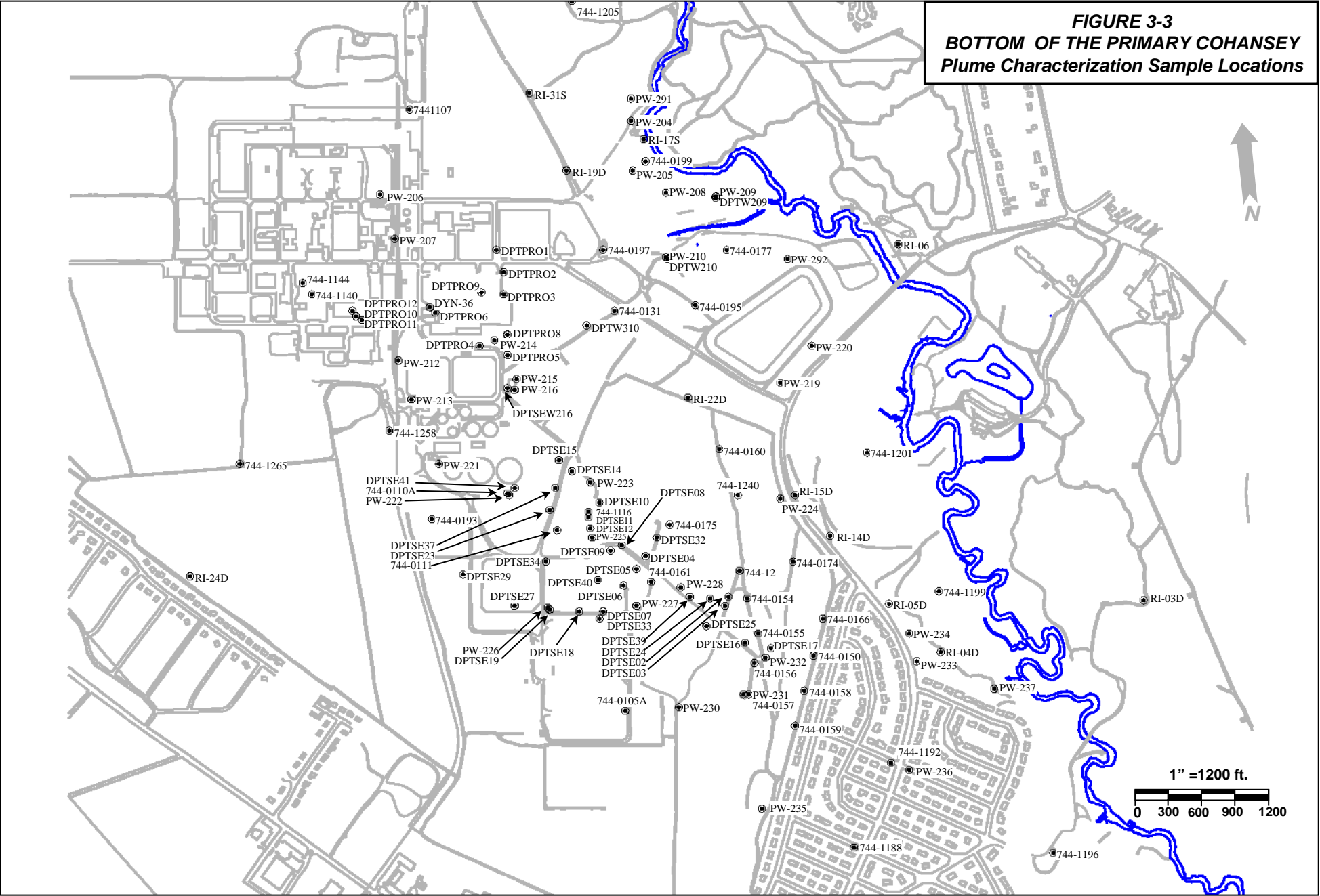


FIGURE 3-3
BOTTOM OF THE PRIMARY COHANSEY
Plume Characterization Sample Locations



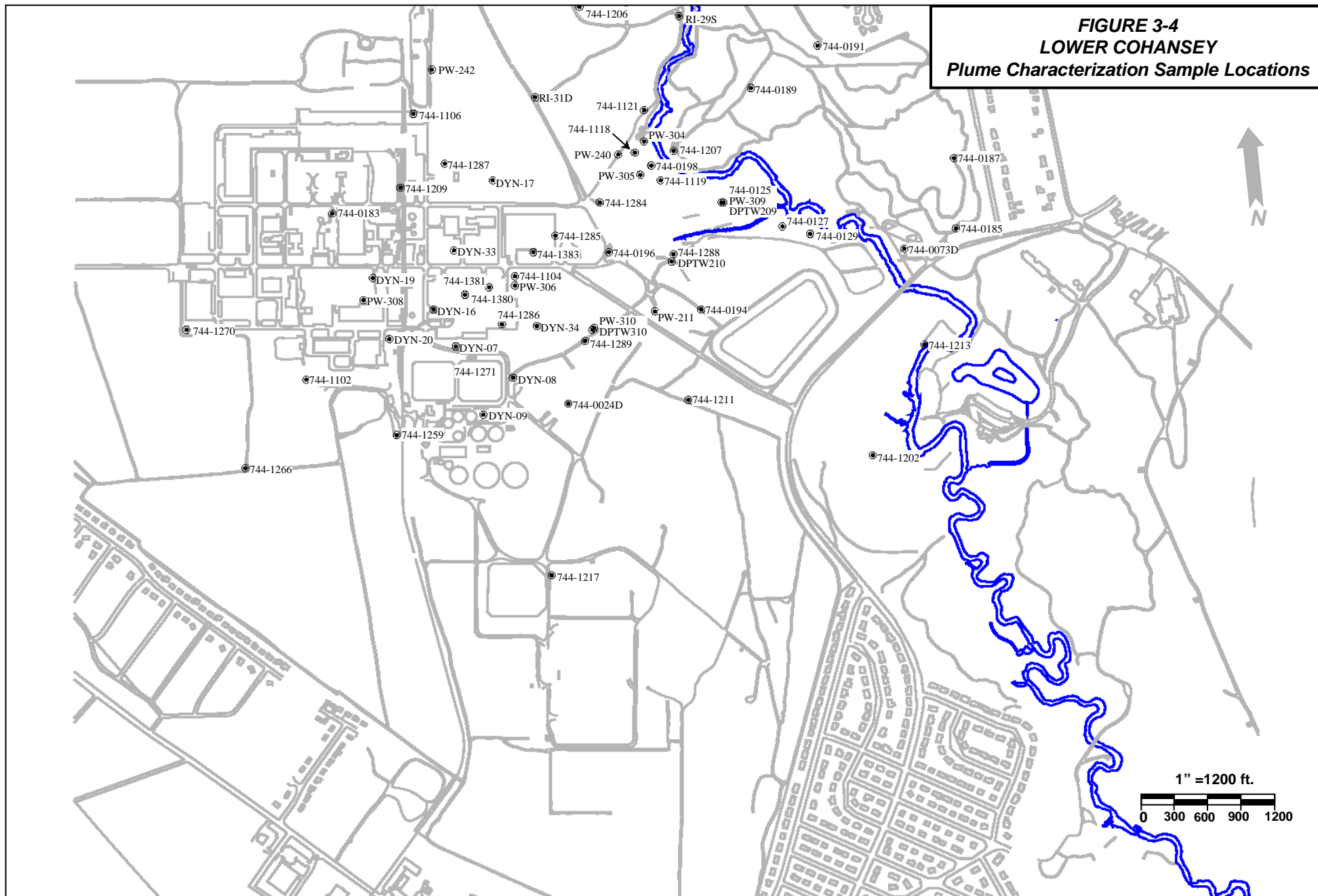
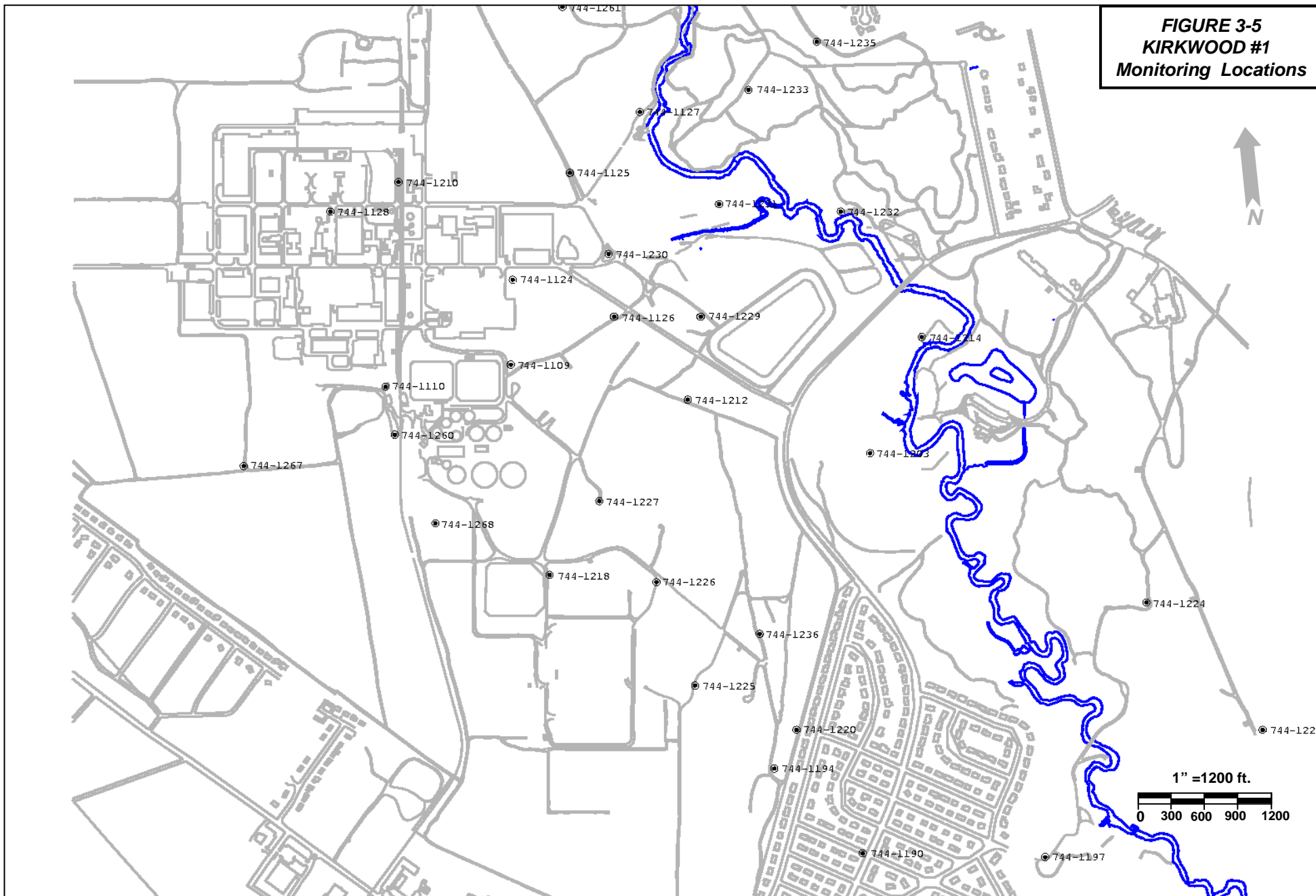


FIGURE 3-5
KIRKWOOD #1
Monitoring Locations



[illegible]

[illegible]

FIGURE 3-9
TOP OF THE PRIMARY COHANSEY
1,2,4-TRICHLOROBENZENE (ppb)

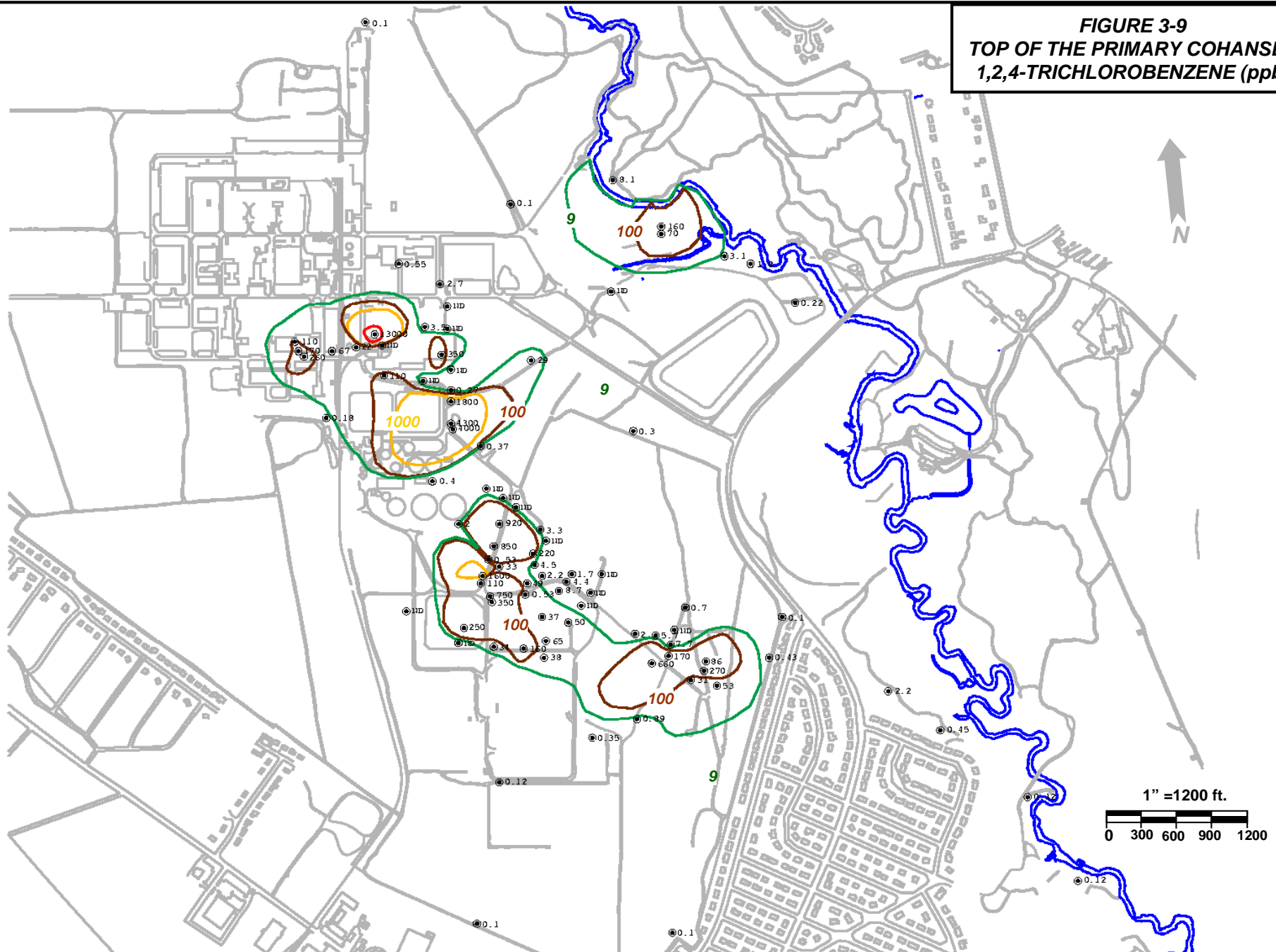


FIGURE 3-10
TOP OF THE PRIMARY COHANSEY
TRICHLOROETHENE (ppb)

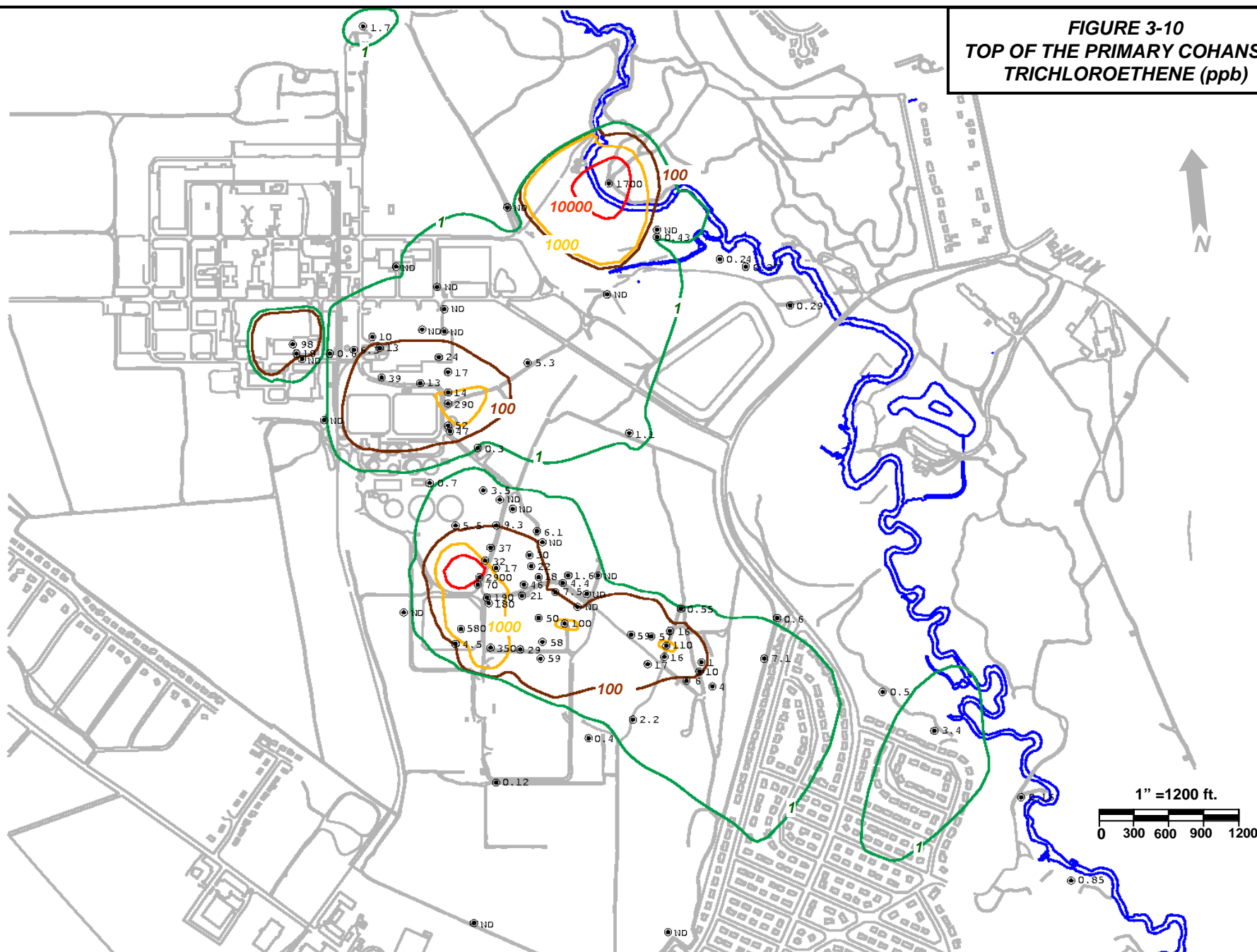


FIGURE 3-11
TOP OF THE PRIMARY COHANSEY
TETRACHLOROETHENE (ppb)

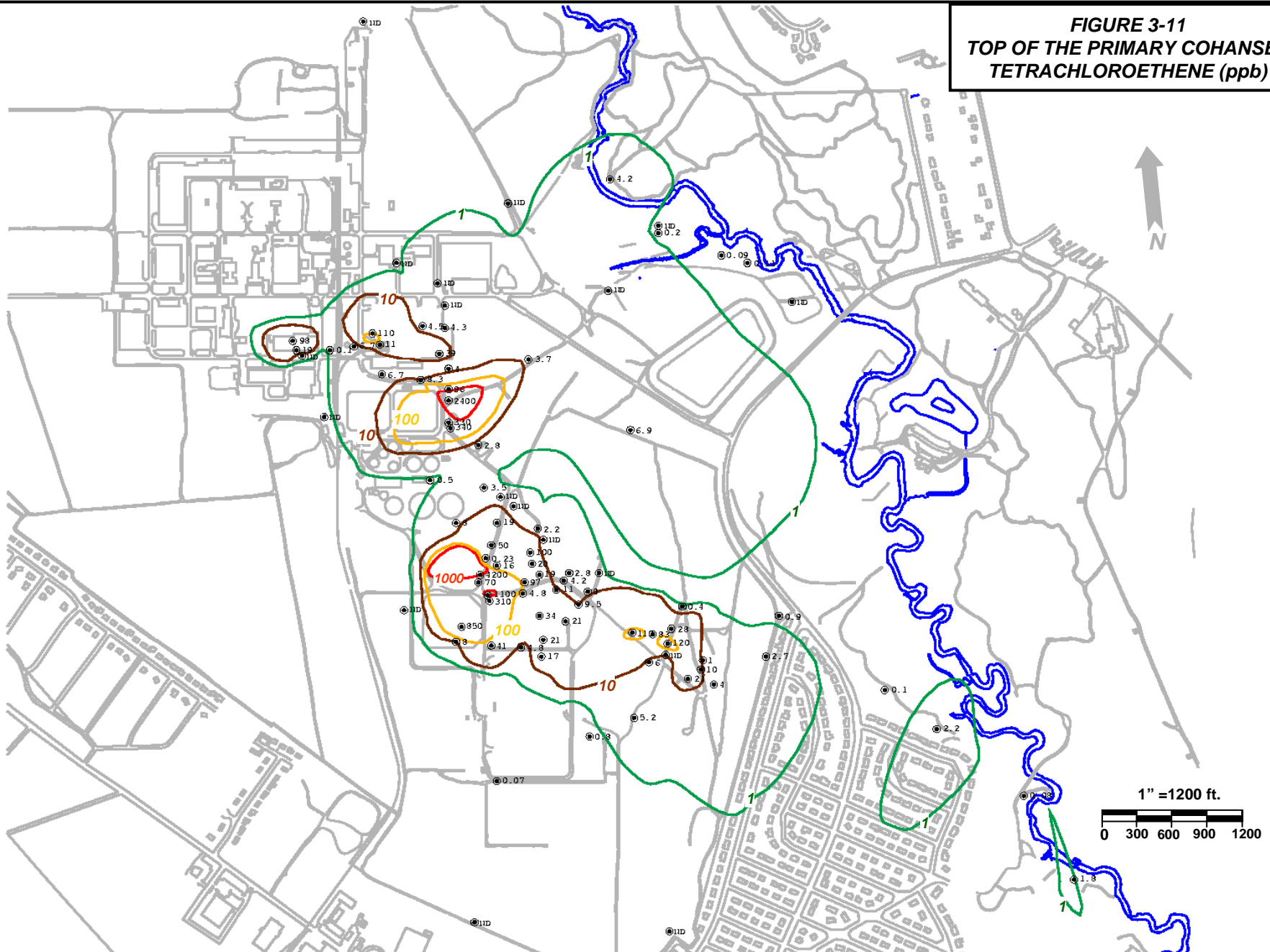


FIGURE 3-12
TOP OF THE PRIMARY COHANSEY
1,2,3-TRICHLOROPROPANE (ppb)

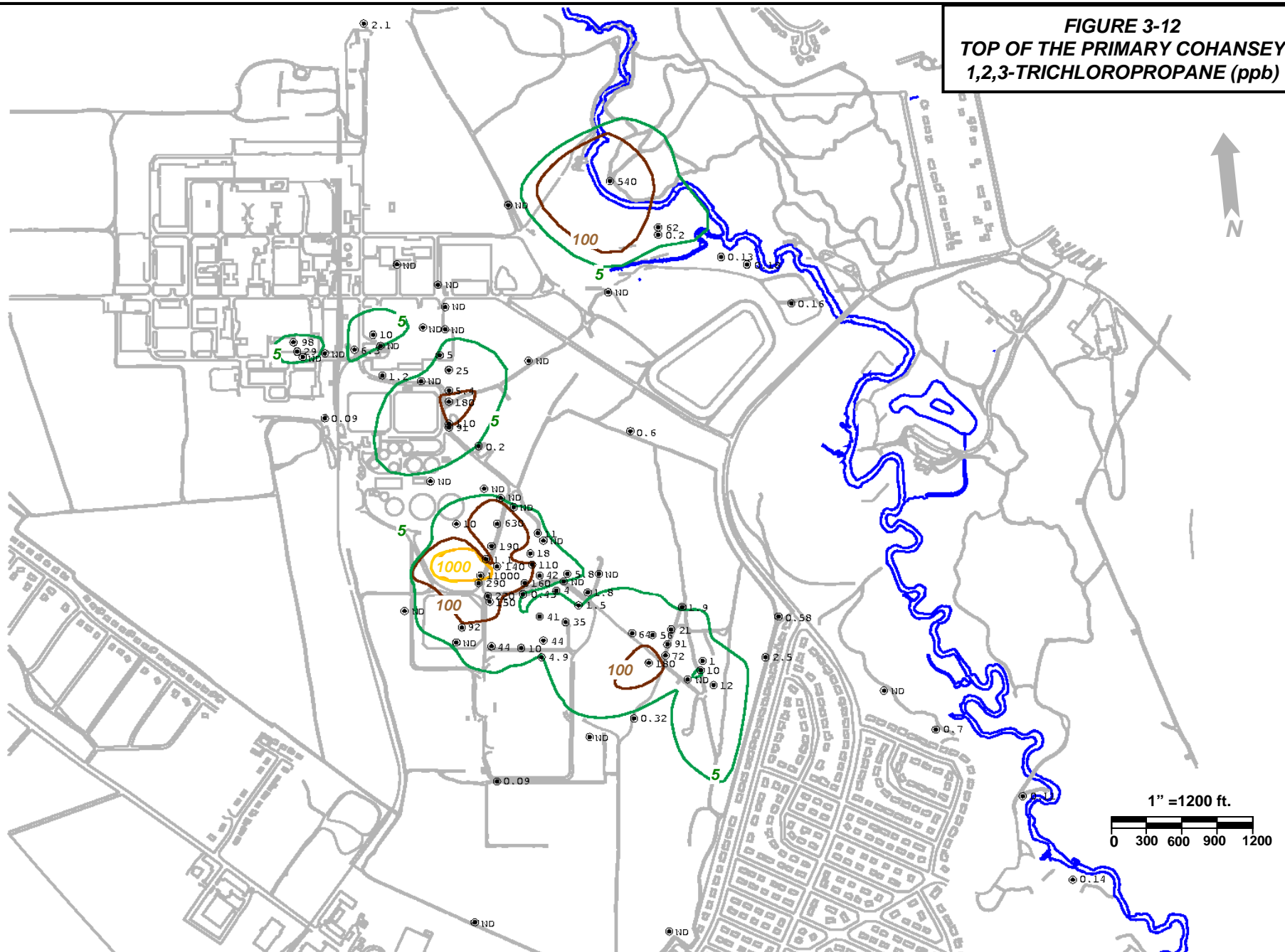
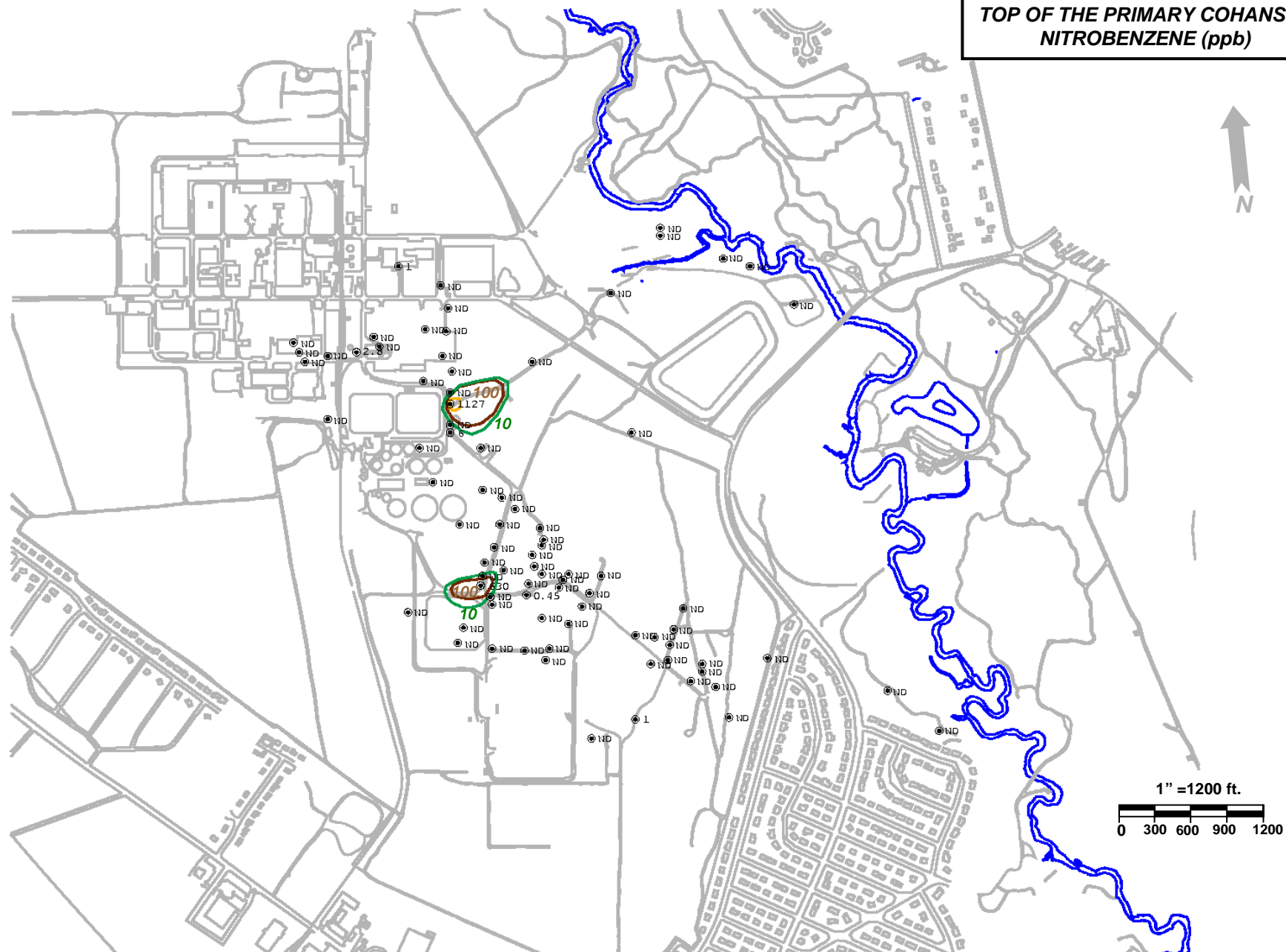


FIGURE 3-13
TOP OF THE PRIMARY COHANSEY
NITROBENZENE (ppb)



NO ESD EXCEEDANCES

FIGURE 3-14
TOP OF THE PRIMARY COHANSEY
NAPHTHALENE (ppb)

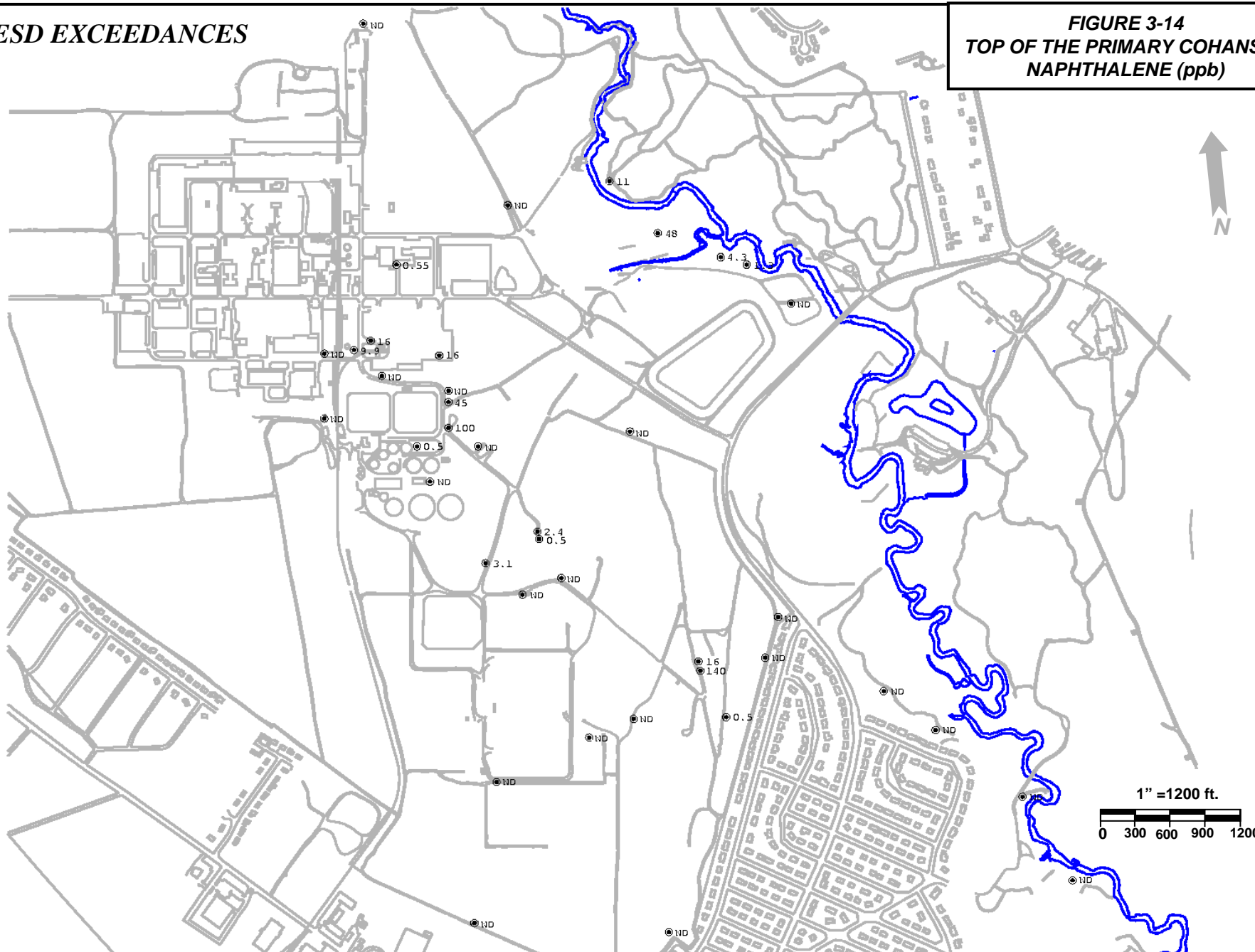


FIGURE 3-20
MIDDLE OF THE PRIMARY COHANSEY
TRICHLOROETHENE (ppb)

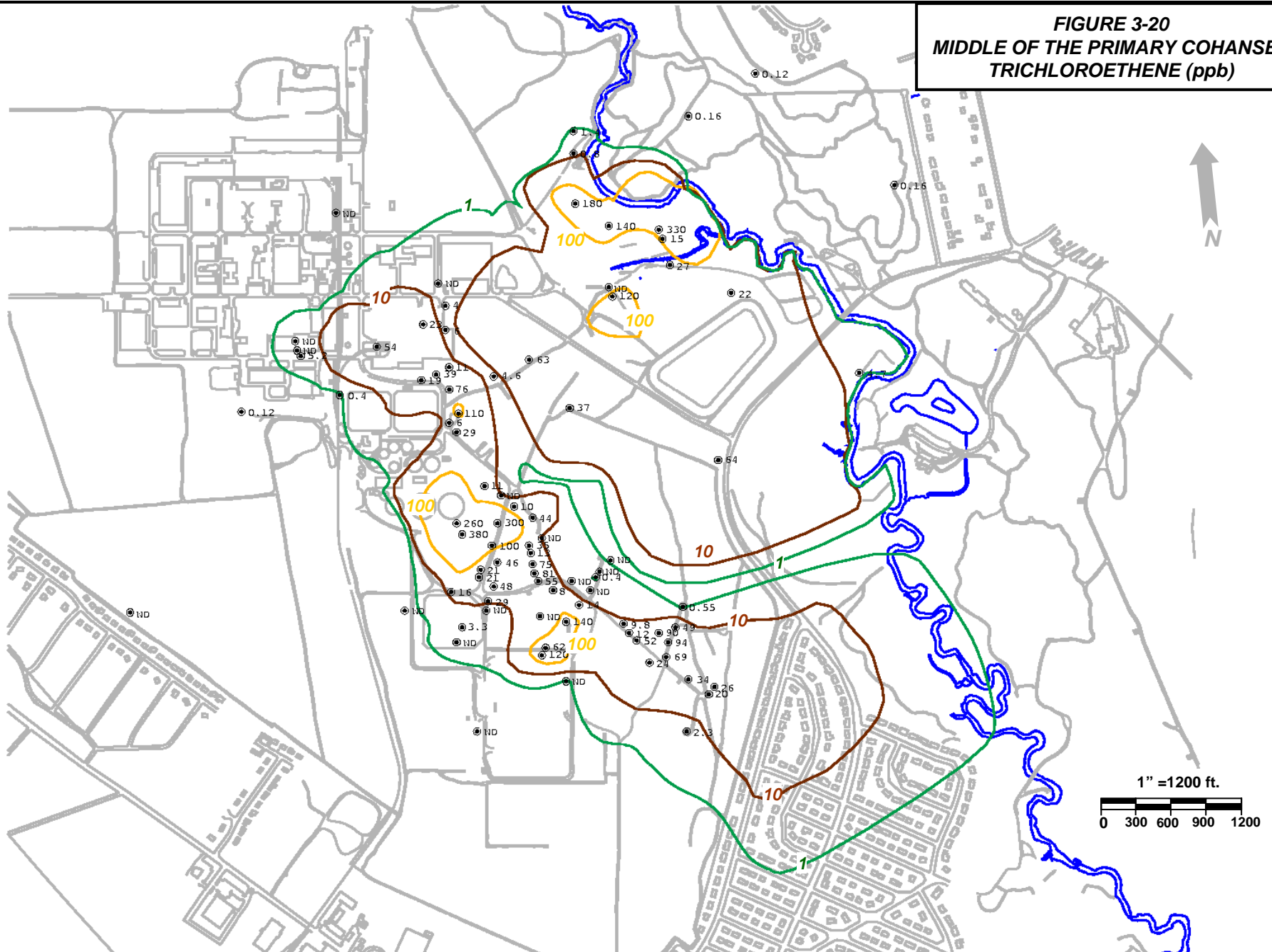


FIGURE 3-24
MIDDLE OF THE PRIMARY COHANSEY
NITROBENZENE (ug/l)

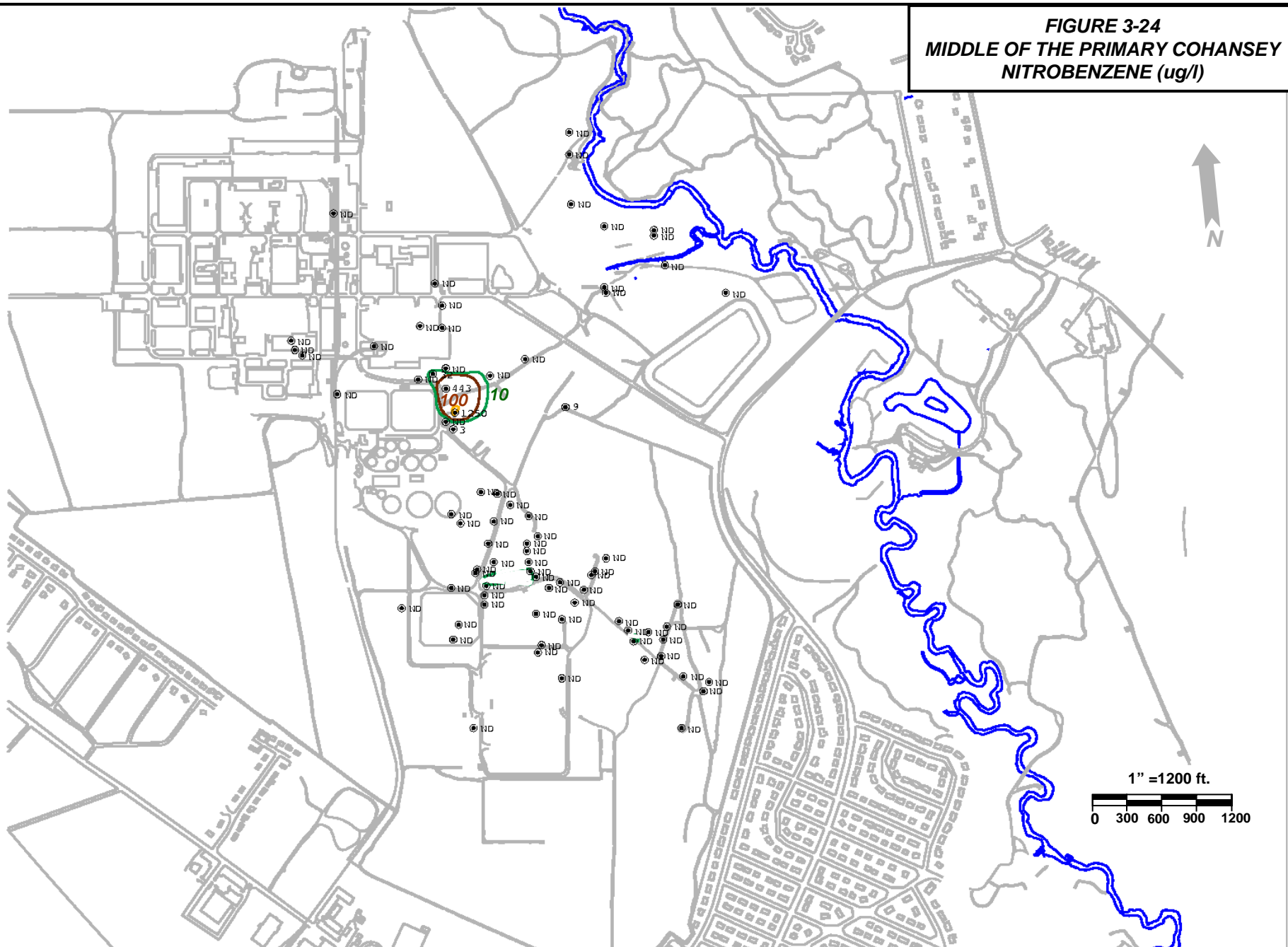


FIGURE 3-26
BOTTOM OF THE PRIMARY COHANSEY
CHLOROBENZENE (ppb)

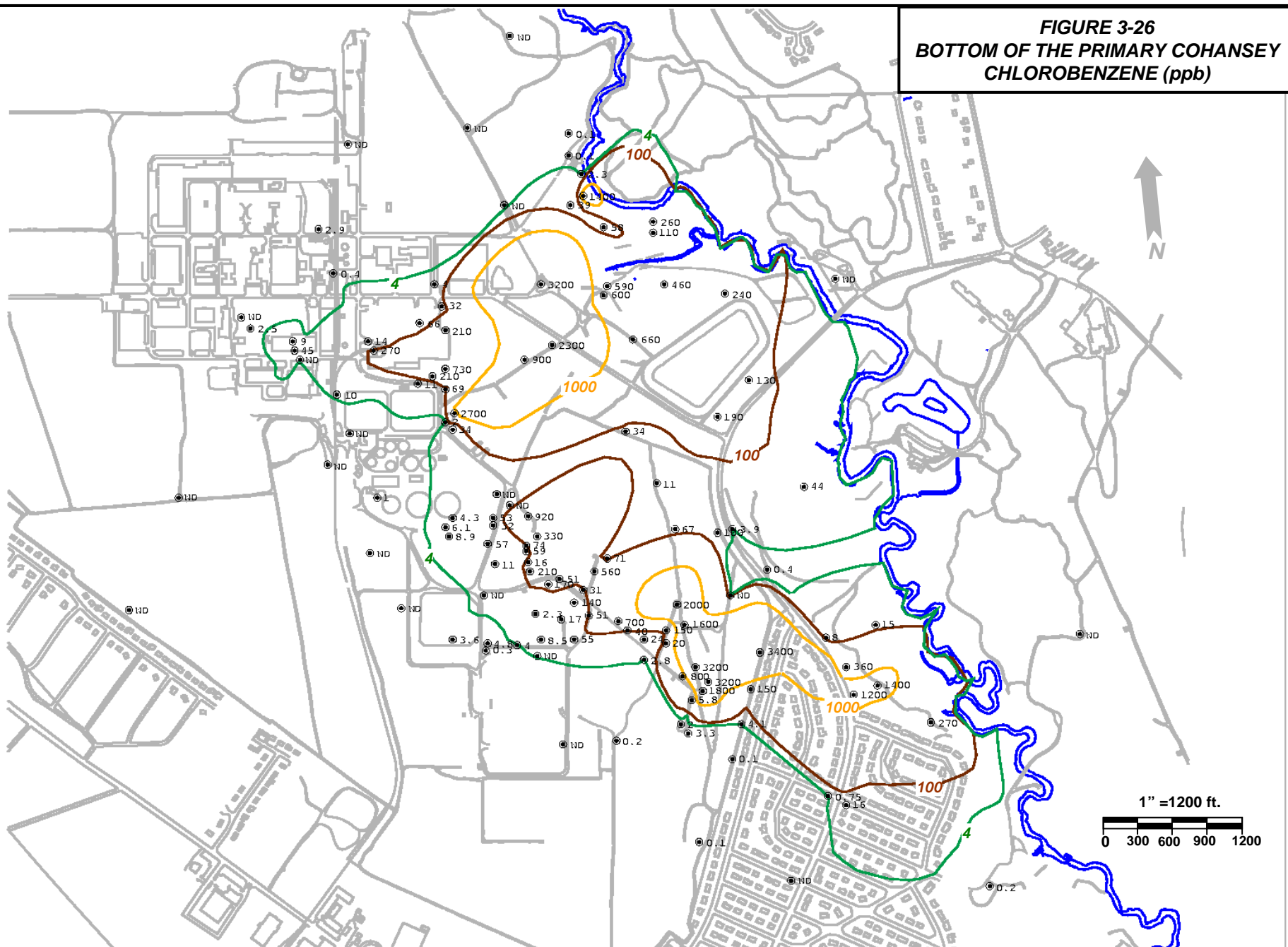


FIGURE 3-27
BOTTOM OF THE PRIMARY COHANSEY
2-CHLOROTOLUENE (ppb)

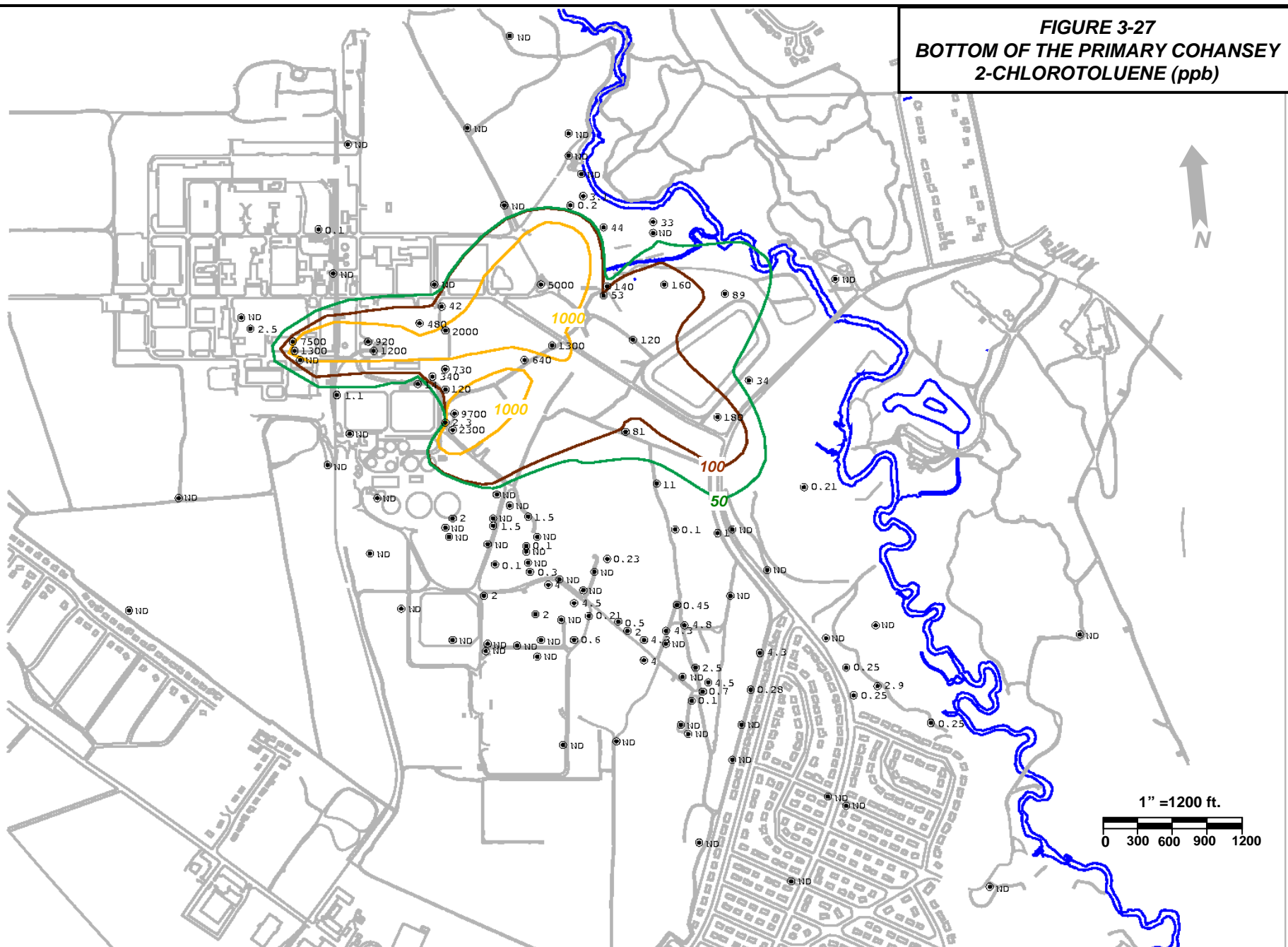


FIGURE 3-28
BOTTOM OF THE PRIMARY COHANSEY
1,2-DICHLOROBENZENE (ppb)

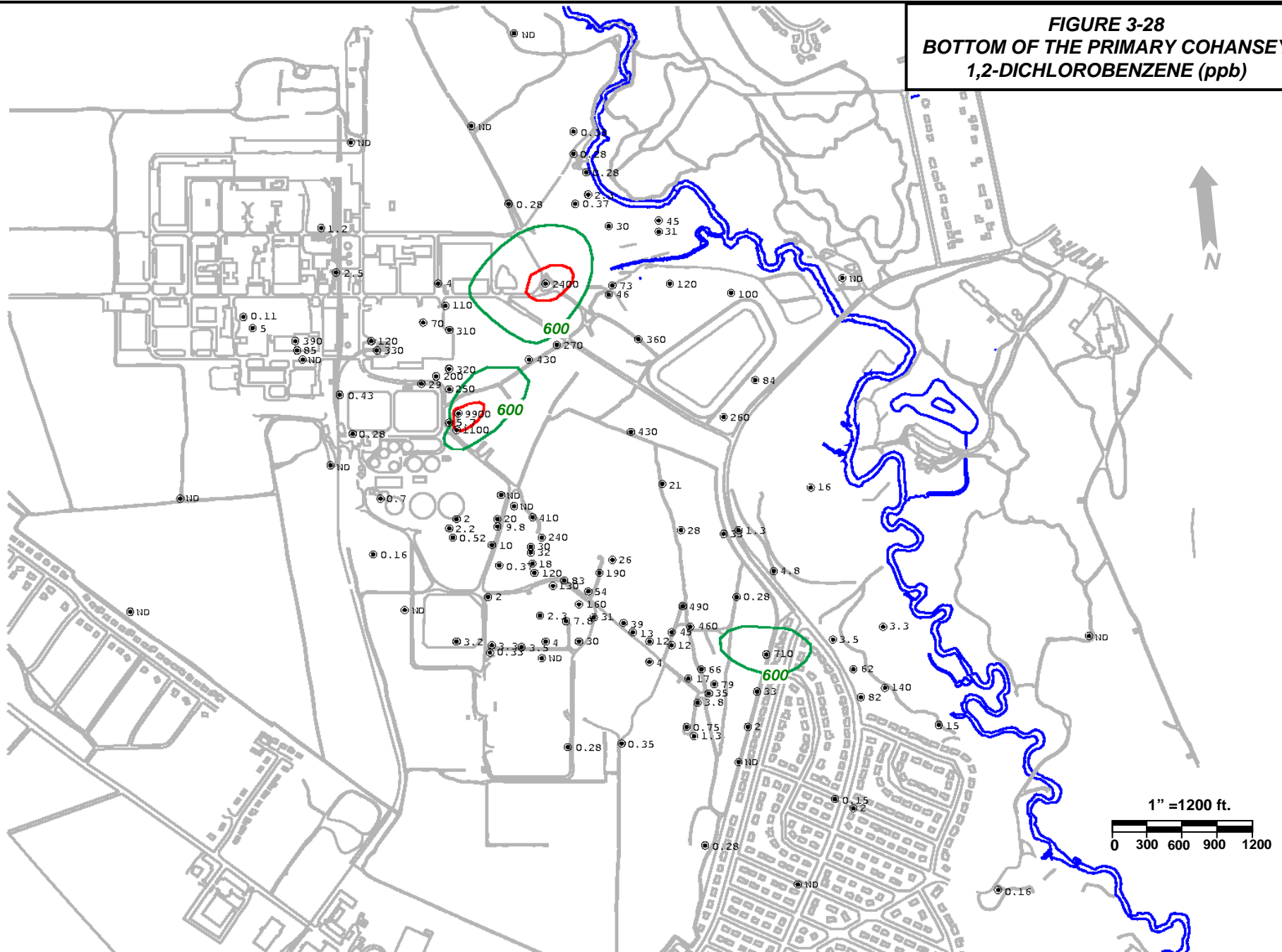


FIGURE 3-31
BOTTOM OF THE PRIMARY COHANSEY
TETRACHLOROETHENE (ppb)

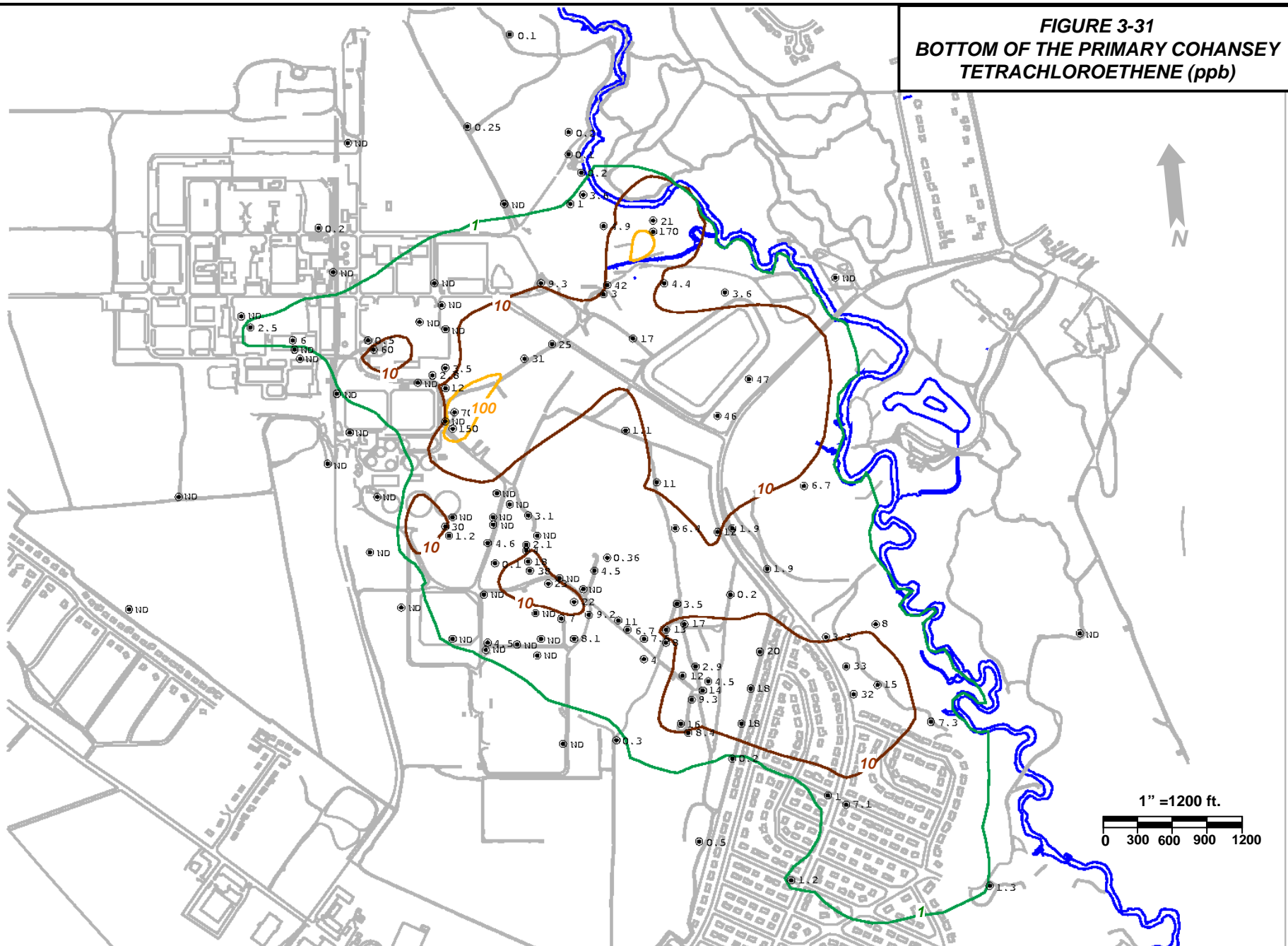


FIGURE 3-32
BOTTOM OF THE PRIMARY COHANSEY
1,2,3-TRICHLOROPROPANE (ppb)

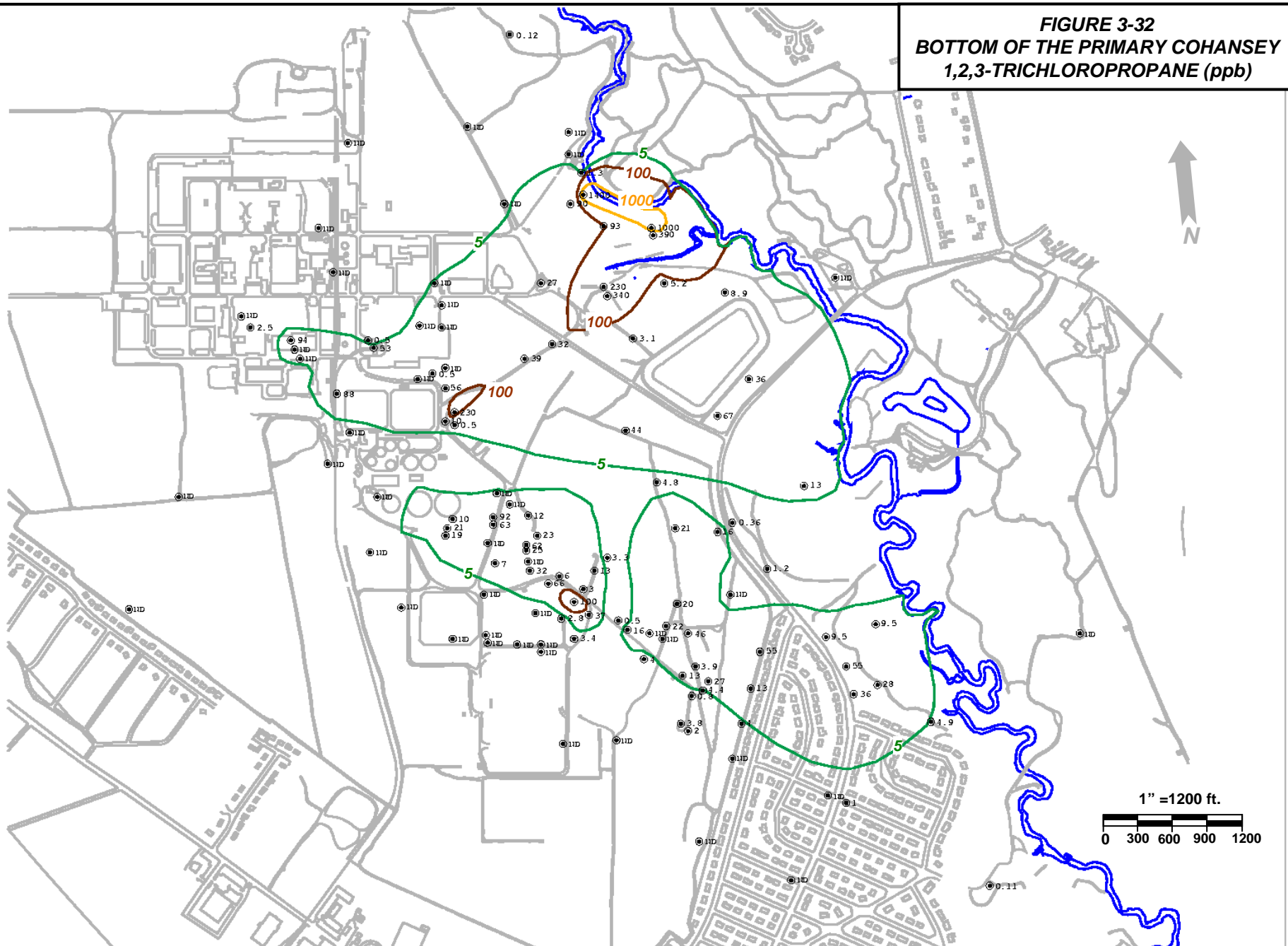
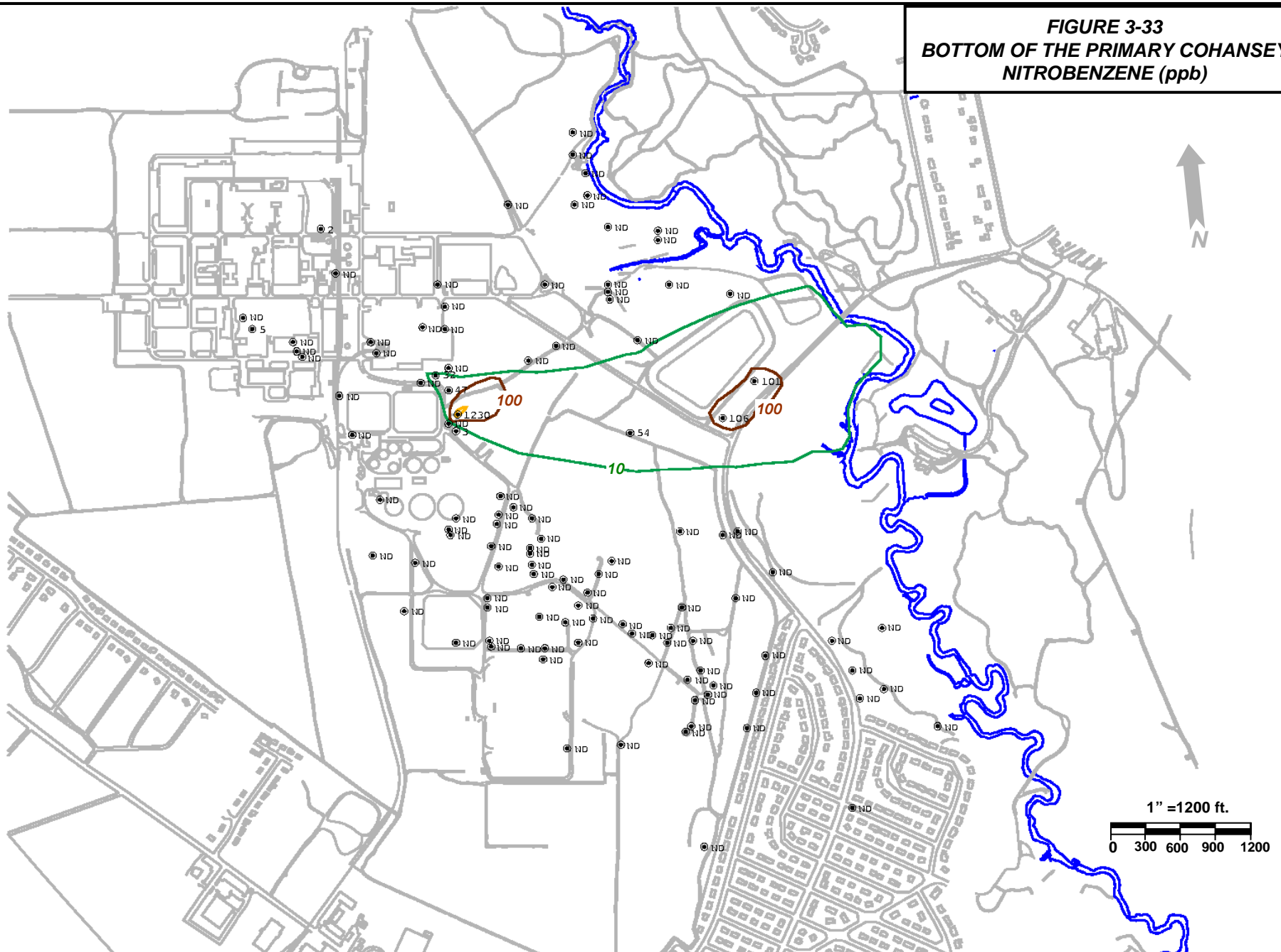


FIGURE 3-33
BOTTOM OF THE PRIMARY COHANSEY
NITROBENZENE (ppb)



[illegible]

FIGURE 3-35
BOTTOM OF THE PRIMARY COHANSEY
ESD Exceedance Ratios

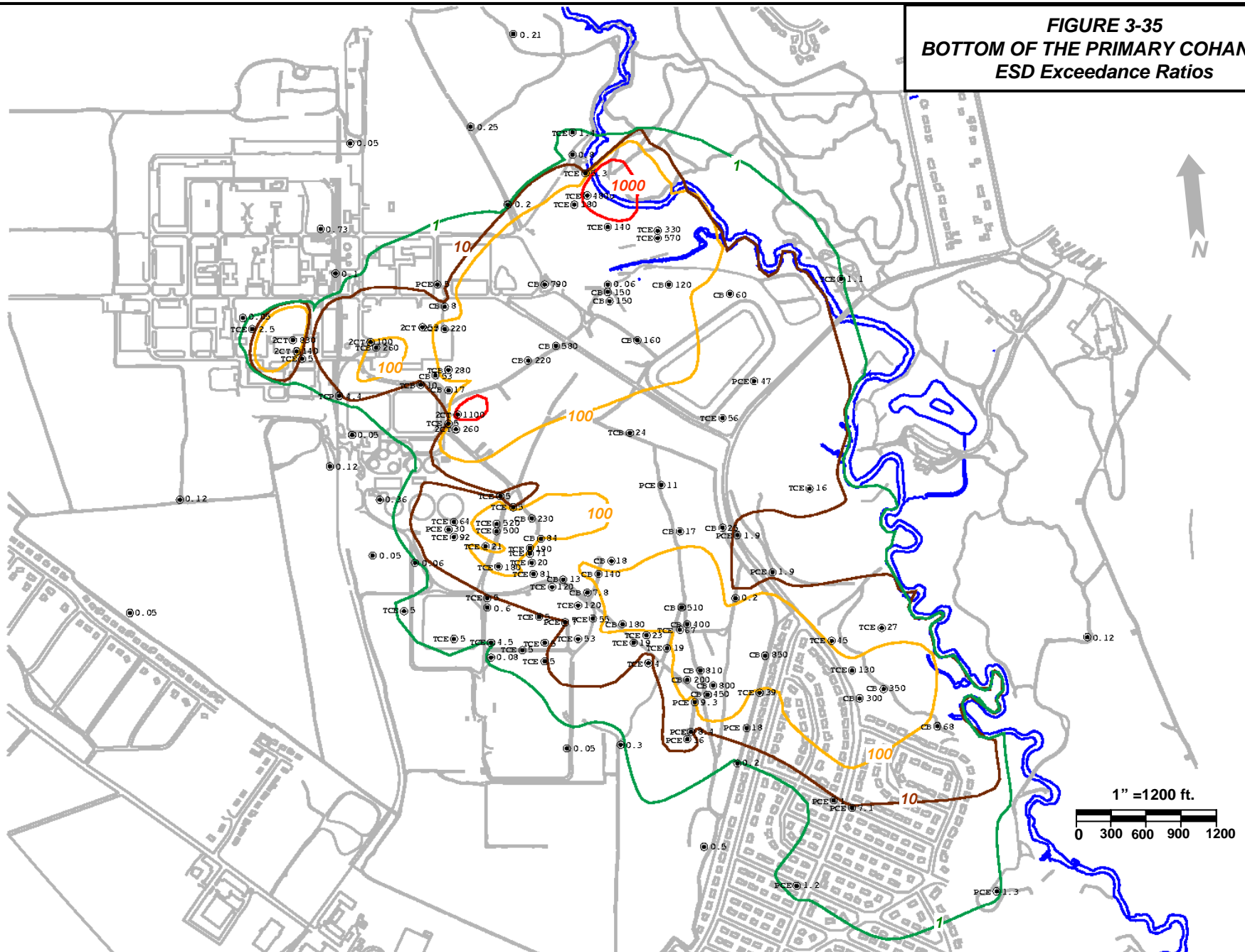


FIGURE 3-36
LOWER COHANSEY
CHLOROBENZENE (ppb)

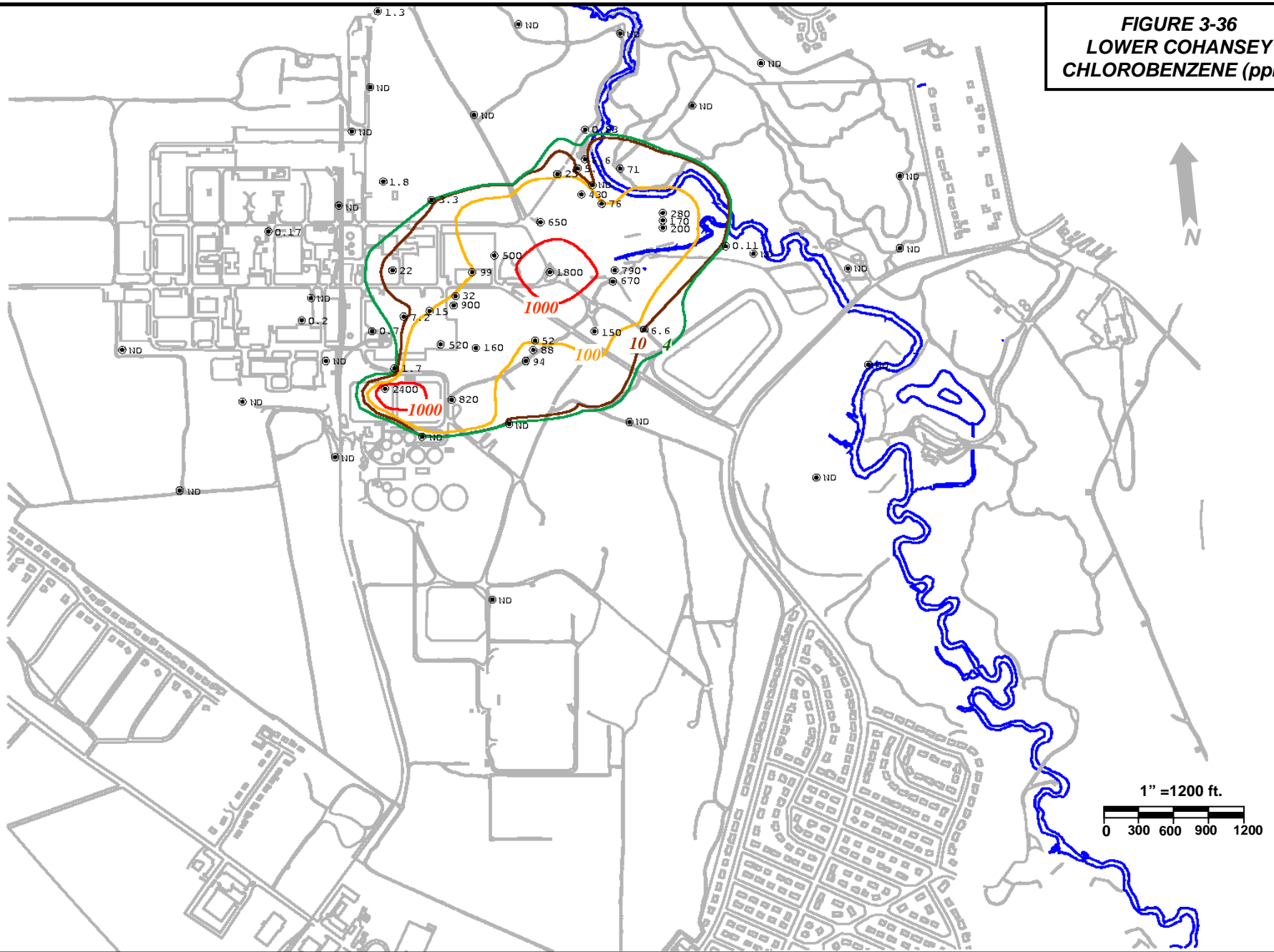


FIGURE 3-37
LOWER COHANSEY
2-CHLOROTOLUENE (ppb)

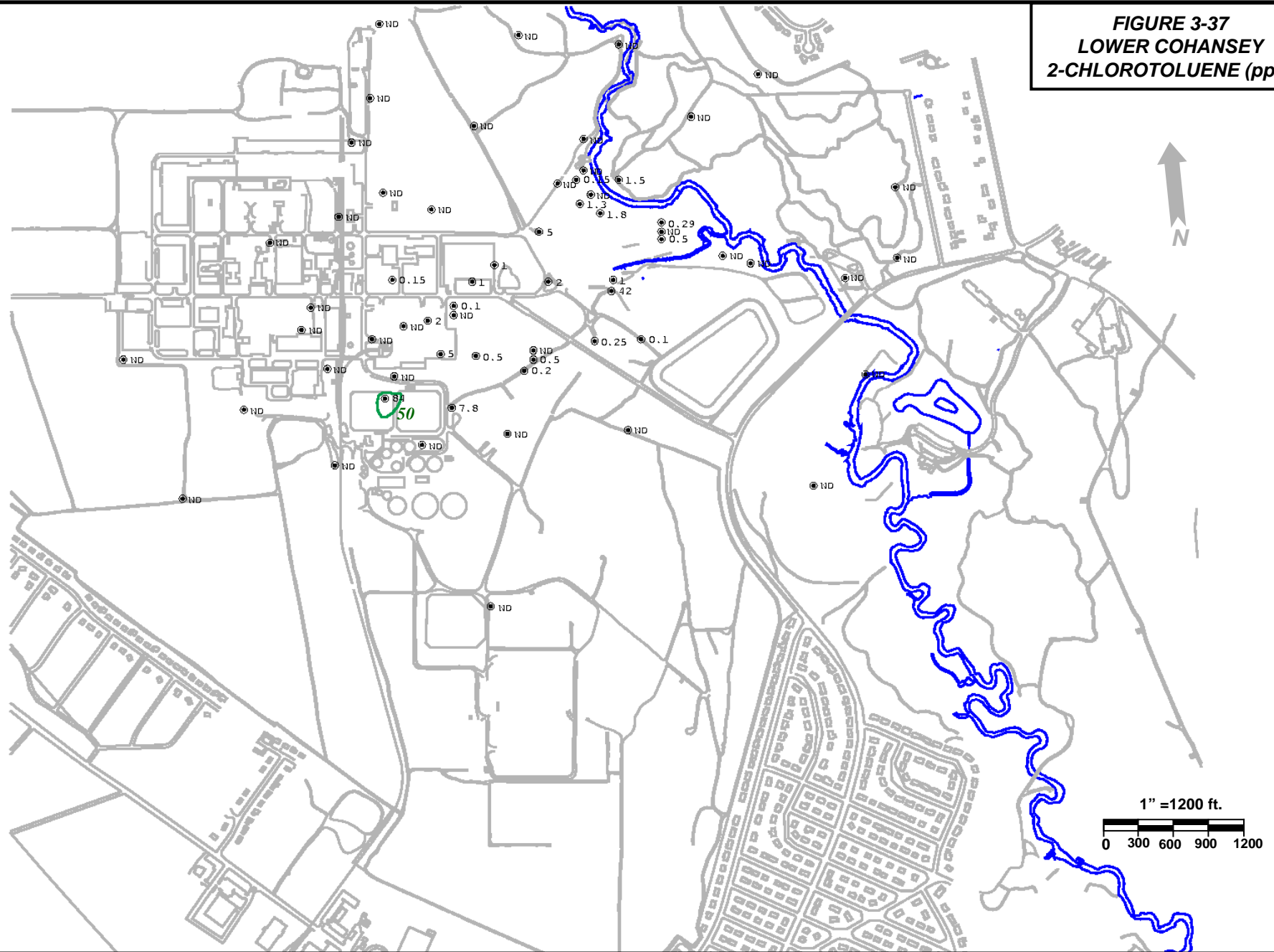


FIGURE 3-38
LOWER COHANSEY
1,2,4-TRICHLOROBENZENE (ppb)

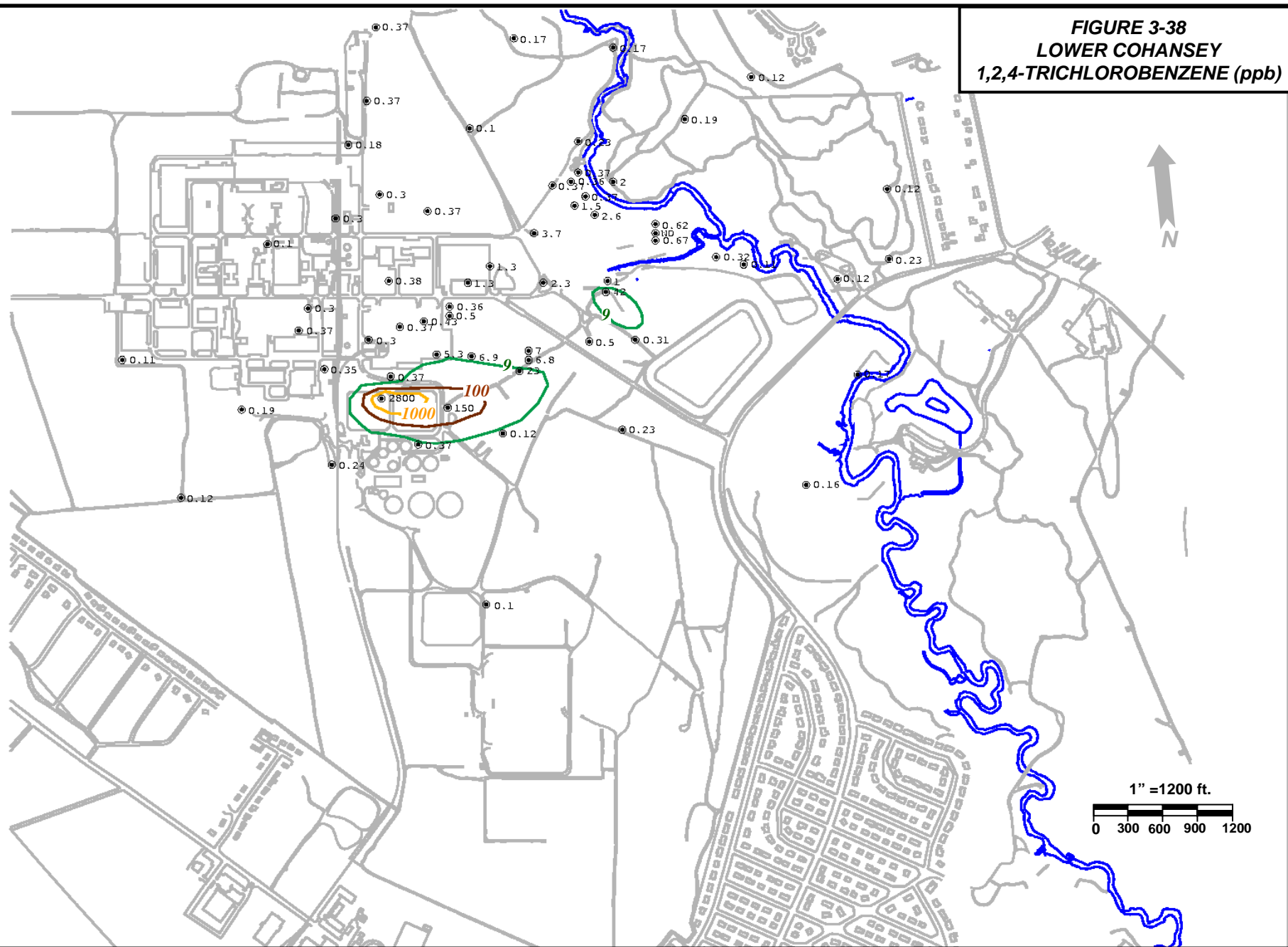


FIGURE 3-39
LOWER COHANSEY
1,2-DICHLOROBENZENE (ppb)

1" = 1200 ft.

0 300 600 900 1200

**FIGURE 3-41
LOWER COHANSEY
TETRACHLOROETHENE (ppb)**

1" = 1200 ft.

0 300 600 900 1200

FIGURE 3-42
LOWER COHANSEY
1,2,3-TRICHLOROPROPANE (ppb)

1" = 1200 ft.

0 300 600 900 1200

FIGURE 3-43
LOWER COHANSEY
NITROBENZENE (ppb)

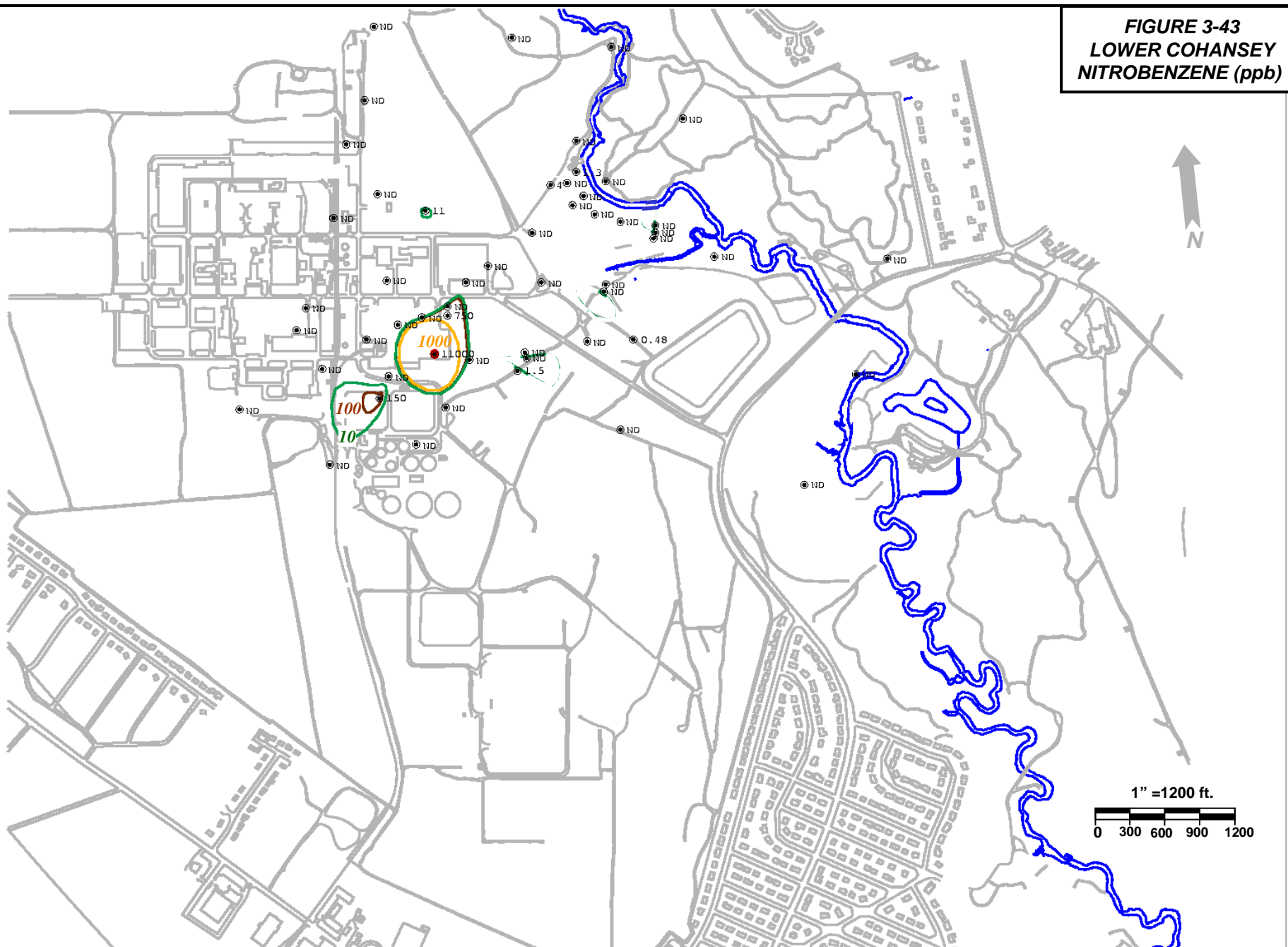
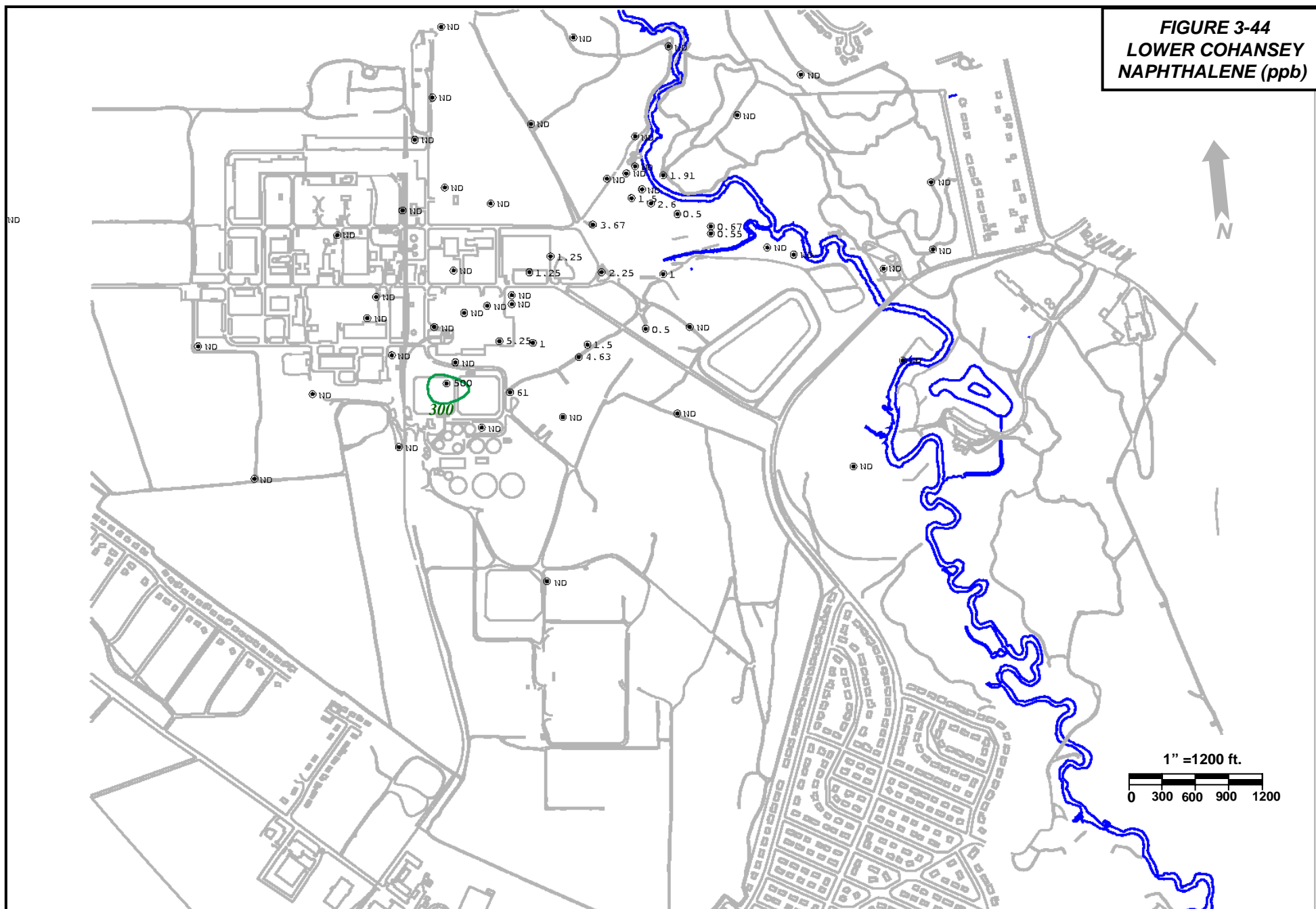


FIGURE 3-44
LOWER COHANSEY
NAPHTHALENE (ppb)



**FIGURE 3-45
LOWER COHANSEY
ESD Exceedance Ratios**

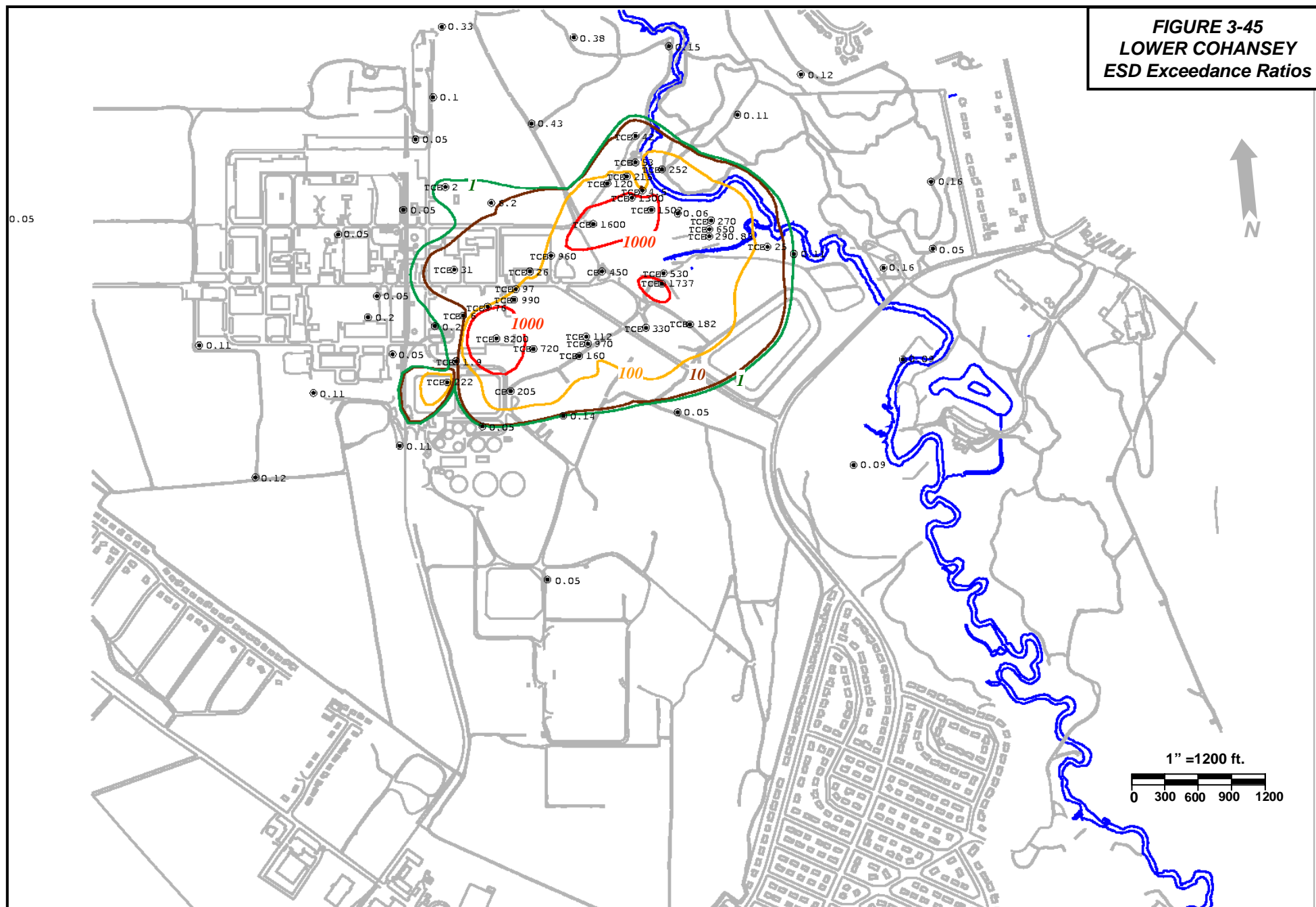


FIGURE 3-46
TOP OF THE PRIMARY COHANSEY
GROUNDWATER METAL COCs (ppb)

Arsenic ESD = 50 ppb

Mercury ESD = 2 ppb

Lead ESD = 15 ppb

ESD Exceedance

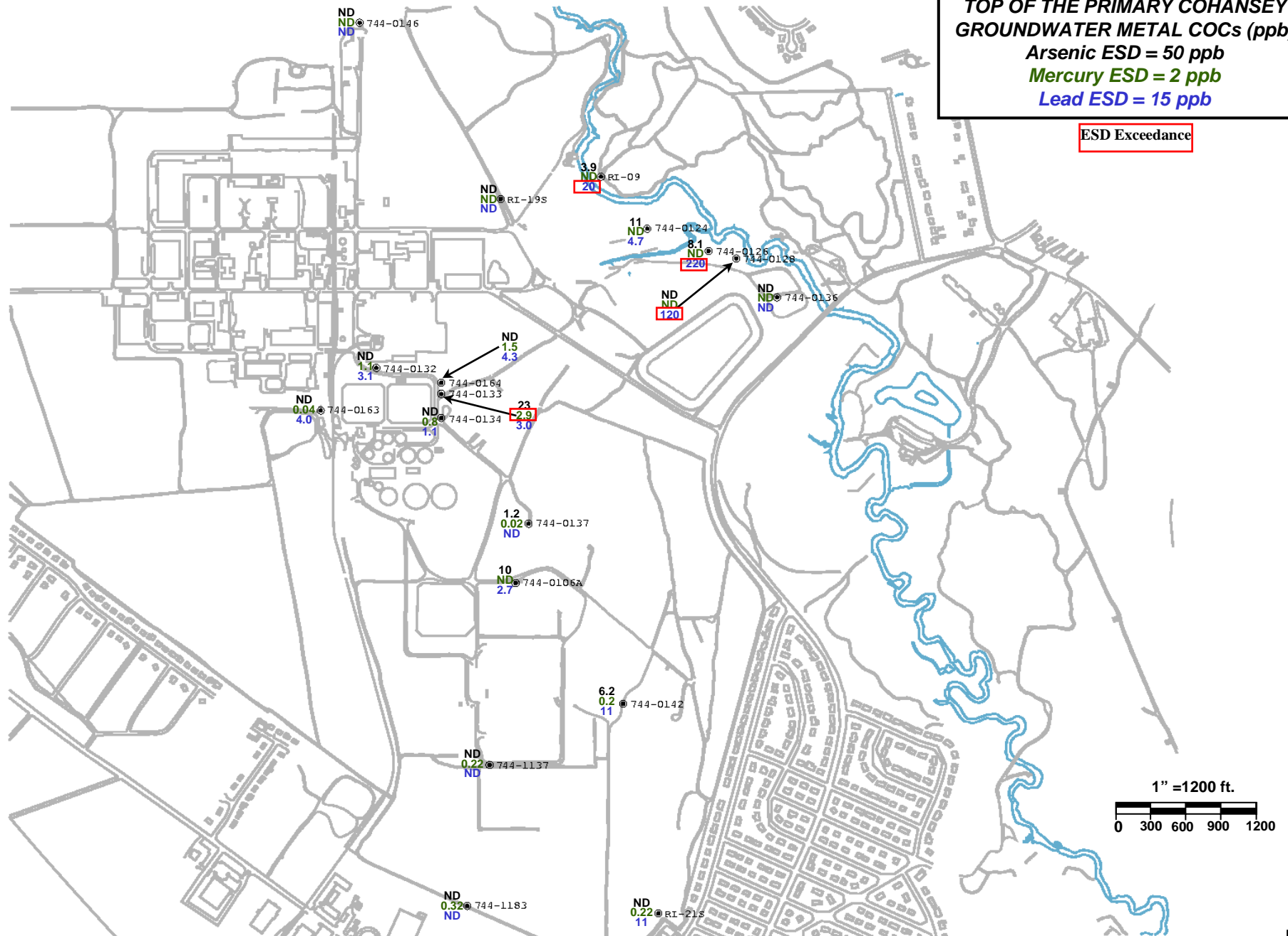


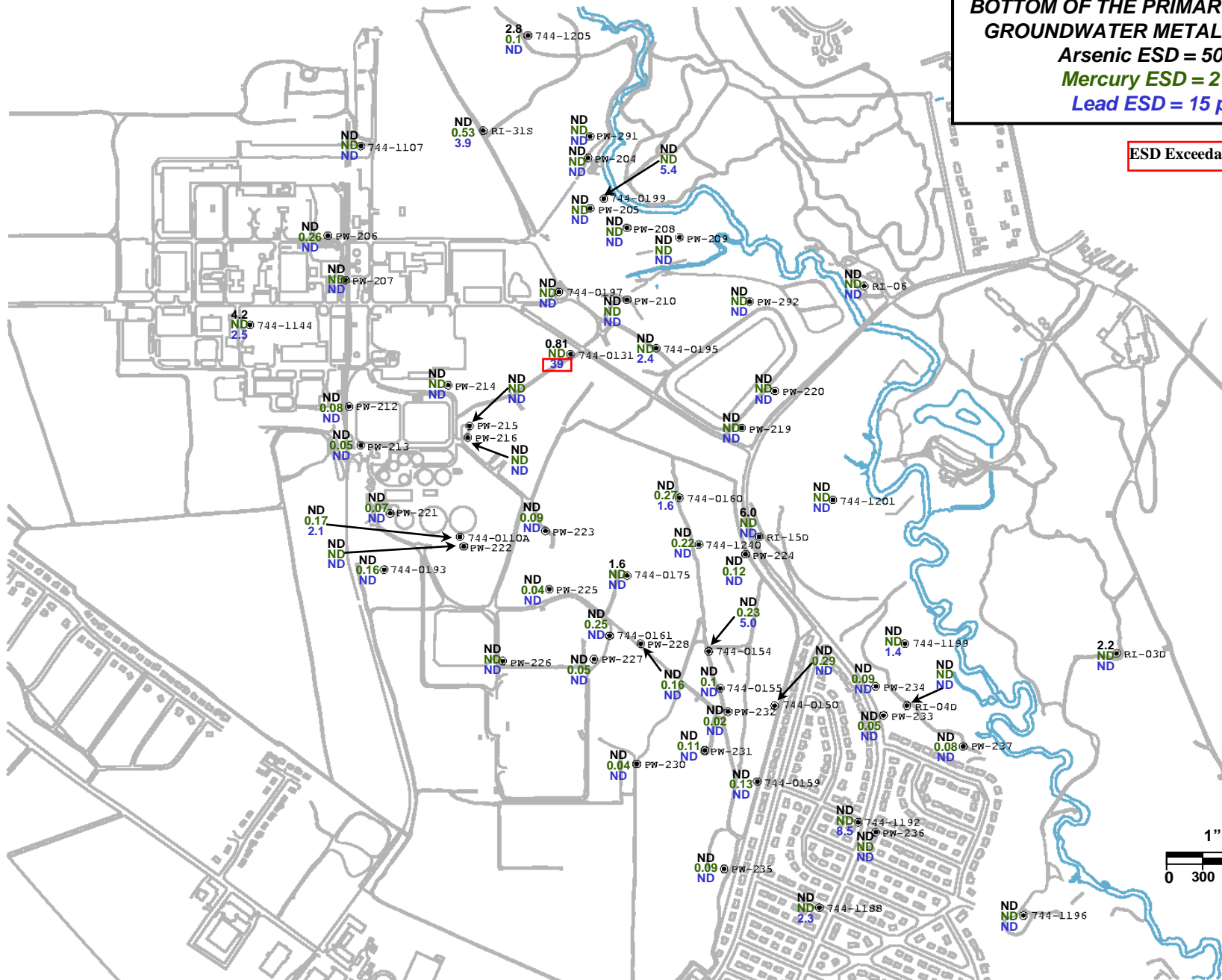
FIGURE 3-48
BOTTOM OF THE PRIMARY COHANSEY
GROUNDWATER METAL COCs (ppb)

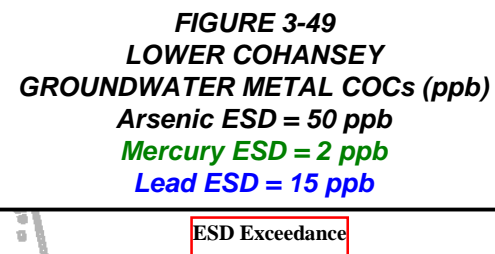
Arsenic ESD = 50 ppb

Mercury ESD = 2 ppb

Lead ESD = 15 ppb

ESD Exceedance





3.4 Source Characterization

The information presented in this section provides the individual source area characterizations based on compilation of the source area characterization data collected to date. Source area characterization raw data is defined as the analytical (chemical) and the field screening data generated from the source area investigations that have been conducted at the Site. For each potential source area, the following information is provided:

- A conceptual model for each source area that depicts the local geology, local hydrogeology and contaminant distribution in the subsurface (i.e., location of contamination with respect to water table and geological layers); and
- A basic statistical characterization of the raw data for contaminants of concern (COCs) for each source area.

The conceptual model is based on knowledge derived from boring logs, chemical sampling and groundwater well information collected from the site during past investigations from the areas. It takes the site-wide information, combines it with results from chemical sampling, and provides focused, area-specific interpretations of:

- Local geology of the source area;
- Local hydrogeology associated with the source area; and
- Contaminant distribution in the subsurface for each area.

3.4.1 *STATISTICAL CHARACTERIZATION*

It is not possible to collect a sample from all points within a source area. Rather, only a limited number of samples can be collected from a source area. The resulting data set is representative of the source area and is used to make geostatistical and statistical predictions of the average concentrations and locations of COCs present in the source areas.

A statistical summary table is provided for each source area. Each table presents the number of samples in each data set, the arithmetic mean or average concentration for each COC, and the 50th, 70th and 95th percentile values for each COC. The number of samples in each data set reflects the analytical and field screening samples that have been collected from the source area investigations conducted to date (see Section 3.3.2). The arithmetic mean represents the average concentration value of the data set. The value represented by the 50% percentile represents the median value, which is another type of average

concentration value. The 50% percentile value is the middle value of the data set (i.e., 50% of the sample results are above this value and 50% of the sample results are below this value). The value represented by the 70th percentile means that 70% of the sample results are below this value and 30% of the sample results are above this value. Likewise, in the case of the 95th percentile, the value represented by the 95th percentile means that 95% of the sample results are below the value and 5% of the sample results are above this value.

A more detailed presentation of the source area characterization data is contained in Appendix A-1 (“Source Area Characterization Data”). This appendix provides the advanced statistical characterization of raw data, including details on data pre-processing, and the detailed conceptual model for each source potential area.

3.4.2 DATA USED IN SOURCE AREA CHARACTERIZATION

There have been several investigations focused on the characterization of the potential source areas at the Site. As discussed in Section 2.3.2, the initial RI Report (NUS 1988a) and the Site Source Control RI Report (CDM 1994a) identified and characterized the potential source areas at the Site. In 1992, additional test pit investigations were conducted in the Filtercake Disposal Area, the Drum Disposal Area and the Borrow Compactor Area to further characterize these areas (Engineering Science 1993a). In 1994, the NAPL Action Plan investigation was implemented to identify and define potential areas of NAPL at the Site and to fill data gap needs with respect to the previously identified potential source areas (Ciba 1998a). In 1998 and 1999, a series of supplemental field investigations were conducted to address the remaining data gaps associated with specific source areas (see Appendix A-1). The information from the above referenced investigations was used for the characterization of the potential source areas, as described below.

3.4.3 CHARACTERIZATION OF SOURCE AREAS

The relationship between the twenty-one (21) potential source areas identified in the Source Control RI (CDM 1994a) and the source area designations used for source area characterization is provided in Table 3-1. For purposes of the FS evaluation, some source areas have been grouped together based on their proximate location to adjacent source areas and similarity of chemical constituents. (deleted example of EQ basins) For example, the Backfilled Lagoon Area is comprised of the five (5) treatment lagoons (Oxidation Lagoon, Settling Lagoon, Final Polishing Pond, Northern Sludge Drying Lagoon and Southern Sludge Drying Lagoon) and the Ocean Outfall Basin, which was built over part of the Final

Polishing Pond. Table 3-1 also indicates whether the source area is located within the north or south plume.

The statistical characterization and conceptual model for each of these source areas is provided in the following subsections.

TABLE 3-1
Source Area Designations

SOURCE AREA CATEGORY	SOURCE AREA DESIGNATION REFERENCED IN SOURCE CONTROL RI (CDM 1994a)	SOURCE AREA DESIGNATION USED FOR SOURCE CONCEPTUAL MODEL	PLUME DESIGNATION
Wastewater Treatment	East Equalization Basin	Equalization Basins Includes the following areas : East and West Basins	North
	West Equalization Basin		
		Backfilled Lagoon Area Includes the following areas: Oxidation Lagoon Settling Lagoon Final Polishing Pond Northern Drying Lagoon Southern Drying Lagoon Ocean Outfall Basin	North
	Oxidation Lagoon		
	Settling Lagoon		
	Final Polishing Pond		
	Northern Drying Lagoon		
	Southern Drying Lagoon		
	Ocean Outfall Basin		
	Old Wastewater Treatment Plant	Old Wastewater Treatment Plant Area Includes the following areas: Old Wastewater Treatment Plant Old Oxidation Lagoon Overflow Basin	South
	Old Oxidation Lagoon (part of Old Wastewater Treatment Plant Area)		
	Overflow Basin (part of Old Wastewater Treatment Plant Area)		
	East Overflow Area		
Solid Waste Disposal	Filtercake Disposal Area	Filtercake Disposal Area	South
	Drum Disposal Area	Drum Disposal Area/Standpipe Burner Area (1)	South
	Lime Sludge Disposal Area	Lime Sludge Disposal Area	South
	Borrow/Compactor Area	Borrow/Compactor Area	North
	Calcium Sulfate Disposal Area	Calcium Sulfate Disposal Area	North
	Casual Dumping Area	Casual Dumping Area	North
Production-Related	Fire Prevention Training Area	Fire Prevention Training Area	North
	Production Area	Former South Dye Area (2)	North
		Former Building 108/Underground Storage Tank Area (2)	North
Secondary Source Area	Marshland Area	Marshland Area (3)	(3)

Notes:

- (1) The Standpipe Burner Area was later identified as a source area after the Source Control RI and is now part of DDA.
- (2) The Former Building 108/Underground Storage Tank Area and the Former South Dye Area were identified as source areas within the Production Area after the Source Control RI.
- (3) The Marshland Area is addressed in Section 4.0.

3.4.3.1 Drum Disposal Area/Standpipe Burner Area

3.4.3.1.1 Conceptual Model

Figure 3-50 presents the conceptual model for the Drum Disposal Area/Standpipe Burner Area. The conceptual model depicts the local geology, local hydrogeology and contaminant distribution in the subsurface (i.e., location of contamination with respect to water table and geological layers). The plan view location and waste disposal history for the Drum Disposal Area/Standpipe Burner Area were provided in Sections 2.2.5.3 and 2.2.5.4, respectively.

The Drum Disposal Area/Standpipe Burner Area is well characterized as a result of extensive source area characterization efforts. There have been nearly 150 subsurface borings conducted in the Drum Disposal Area/Standpipe Burner Area. The area is quite heterogeneous with respect to contaminant distribution and required over 1,800 samples to fully characterize the chemical distribution and composition of the source area. These samples include 500 chemical samples and 1,300 NAPL field screening samples. Sample locations are depicted on the figure. Nearly all COC mass in the DDA is found in the unsaturated and saturated (including perched water and Yellow Clay) zones of the Standpipe Burner Area, Stacked Drum and Non-Intact Drum subareas of the Drum Disposal Area. Very little COC mass is found in or below the Iron Filing subarea of the Drum Disposal Area. Details on COC mass distribution are provided in Appendix A-1.

The unsaturated zone extends from land surface to perched water. Depending on seasonal fluctuations, it is approximately 16 to 18 feet from land surface to perched groundwater of the Upper Cohansey. The main contaminants in the unsaturated zone include chlorobenzene, 1,2-dichlorobenzene, 1,2,4-trichlorobenzene and naphthalene. Substantial COC mass resides in the unsaturated zone across much of the DDA.

These same contaminants (chlorobenzene, 1,2-dichlorobenzene, 1,2,4-trichlorobenzene and naphthalene) also dominate the perched groundwater zone of the Upper Cohansey. The thickness of groundwater varies depending on seasonal fluctuations but is often in the vicinity of approximately 5 feet thick.

As shown on the figure, the Upper Cohansey perched groundwater is supported by the Cohansey Yellow Clay. The Cohansey Yellow Clay Member is present beneath the majority of this source area. The clay

disappears or becomes insignificant along the northeastern portion of the area. The clay is thickest in the eastern portion of the Standpipe Burner Area (up to 14 feet). In general, it thins towards the northeast until it disappears. The top and bottom of the clay is depicted on the figure. It should be noted that the formation thickness includes some thin sand/clay interfingering. Where this exists, the sand stringers have evidently provided a pathway for limited perched groundwater movement to occur into or even through the clay unit. Although present at lower concentrations than in the unsaturated and perched water zones, chlorobenzene, 1,2-dichlorobenzene, 1,2,4-trichlorobenzene and naphthalene are found throughout much of the Cohansy Yellow Clay beneath the Drum Disposal Area.

The regional groundwater table of the Primary Cohansey occurs at elevations ranging from 33 feet below land surface in the western portion to 36 feet below land surface (BLS) in the eastern portion of the area. Low levels of COCs extend into this saturated zone and on down to the top of the Cohansey/Kirkwood. The top of the Cohansey/Kirkwood Transition Member occurs at an approximate depth of 35 feet BLS beneath the Drum Disposal Area/Standpipe Burner Area. The Cohansey/Kirkwood Transition Member separates the Primary Cohansey groundwater from lower water-bearing geological units.

3.4.3.1.2 Statistical Characterization

A statistical summary of the sample data is presented in Table 3-2. The major COCs are 1,2-dichlorobenzene, naphthalene, chlorobenzene and 1,2,4-trichlorobenzene.

3.4.3.1.3 Drum Characterization

There were four (4) test pits excavated during the 1992 test pit investigation (Engineering Science 1993a) in the Non-Intact Drum Area. Non-intact drums and soils mixed with non-drummed solid waste were found in all test pits. The types of material found in the test pits included filtercake, filter papers, solid resins and dyes.

During a 1992 test pit investigation at the Stacked Drum Area (Engineering Science 1993a), a total of 315 drums were removed from six test pits. The test pits contained from one to four layers of stacked drums. Only intact drums were encountered; no non-intact or non-drummed wastes were found in any of the test pits. The majority of the drums exposed and removed were in good condition. In general, the categories of waste materials found in the drums were in agreement with categories listed above from the E-149. For example, the primary category of material found in the drums was epoxy resins/resin residues, with sparkler salts comprising the largest percentage of the category.

In two (2) test pits excavated at the Iron Filings Area during the 1992 test pit investigation (Engineering Science 1993a), the primary waste was a dry black residue, which was identified as the iron filings. No intact or non-intact drums were found in this area.

TABLE 3-2

Statistical Summary for Drum Disposal Area/Standpipe Burner Area

Chemical of Concern	N	Mean (ppm)	50 th (ppm)	70 th (ppm)	95 th (ppm)
1,2,3-Trichloropropane	1753	0.566	0.01(nd)	0.01(nd)	0.360
1,2,4-Trichlorobenzene	1814	25.664	0.01(nd)	0.01(nd)	5.000
1,2- Dichlorobenzene	1815	346.149	0.01(nd)	0.01(nd)	4.576
2-Chlorotoluene	1752	0.432	0.01(nd)	0.01(nd)	0.137
Chlorobenzene	1819	49.180	0.01(nd)	0.01(nd)	2.711
Naphthalene	1811	59.202	0.01(nd)	0.01(nd)	2.446
Nitrobenzene	1796	2.871	0.01(nd)	0.01(nd)	0.600
Tetrachloroethene	1811	5.744	0.01(nd)	0.01(nd)	0.600
Trichloroethene	1798	1.236	0.01(nd)	0.01(nd)	0.322

Notes:

N = Number of samples

Mean = Arithmetic average concentration

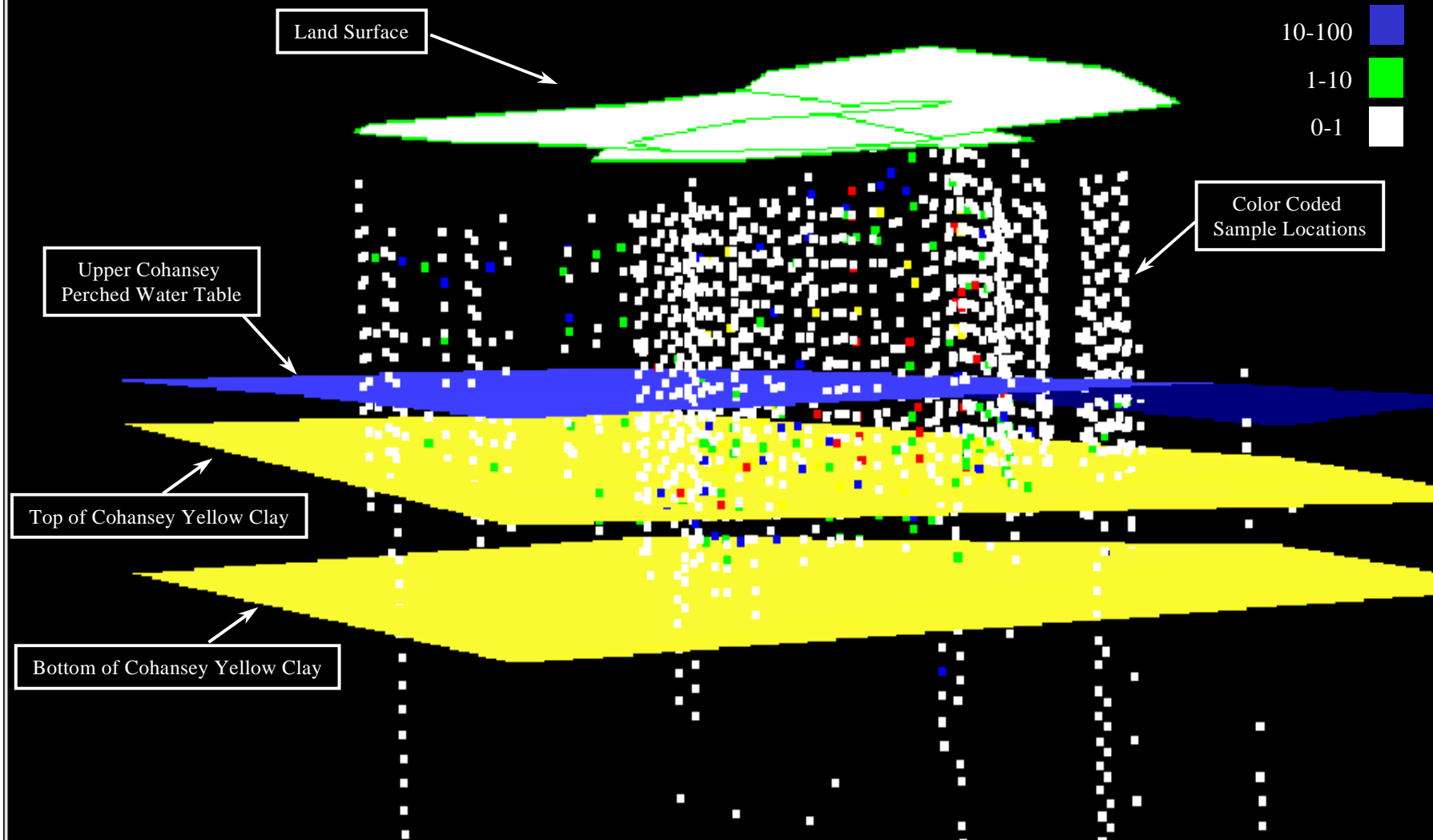
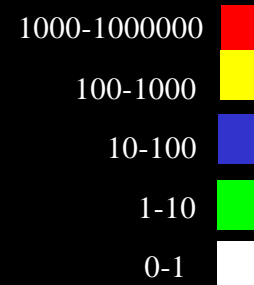
50th = For the data set, 50% of values were below and 50% of the values were above this concentration

70th = For the data set, 70% of values were below and 30% of the values were above this concentration

95th = For the data set, 95% of values were below and 5% of the values were above this concentration

Figure 3-50
Drum Disposal Area/Standpipe Burner Area
Color Coded Sample Locations

TOTAL COCs ppm



dda_all_sam1.str

3.4.3.2 Filtercake Disposal Area

3.4.3.2.1 Conceptual Model

Figures 3-51 and 3-52 present the conceptual model for the Filtercake Disposal Area. The conceptual model depicts the local geology, local hydrogeology and contaminant distribution in the subsurface (i.e., location of contamination with respect to water table and geological layers). The plan view location and waste disposal history of the Filtercake Disposal Area was provided in Section 2.2.5.1.

There have been over 50 subsurface borings conducted at the Filtercake Disposal Area. This source area required over 500 samples (200 chemical samples and 300 NAPL field screening samples) for adequate characterization. Sample locations are depicted on the figure.

The unsaturated zone extends from land surface to the top of the perched water. As shown on Figure 3-51, the upper portion of the unsaturated zone is comprised of filtercake residual derived from wastewater treatment activities. The main organic COC present is 1,2,4-trichlorobenzene. Mercury is an area-specific inorganic COC for the area. Most mercury present in the area resides in the unsaturated zone in the filtercake residue. The lower portion of the Filtercake Disposal Area unsaturated zone is comprised of unsaturated Upper Cohansey sand and the Trench Disposal Area (Trench Disposal Area). The unsaturated sand is characterized by low (i.e., less than 1 part per million, or ppm) of organic COCs. Mercury is present here but at much lower concentrations than in the overlying filtercake residue material. The Trench Disposal Area has high concentrations of COCs. These include high levels of chlorobenzene, naphthalene, nitrobenzene and 1,2,4-trichlorobenzene.

Perched water is present beneath the Filtercake Disposal Area. Depending on seasonal fluctuations, it is approximately 16 to 18 feet from land surface to perched groundwater of the Upper Cohansey. As a result, it is likely that the bottom of the Trench Disposal Area is in contact with the perched water during times of high water table in the Upper Cohansey perched groundwater zone. During times of low water levels, the perched water surface is below the bottom of the Trench Disposal Area.

Saturated Upper Cohansey Sands located beneath the Trench Disposal Area have high COC concentrations for nitrobenzene, naphthalene, chlorobenzene and 1,2-dichlorobenzene. Saturated sands away from the Trench Disposal Area area have only low levels (i.e., less than 1 ppm) of COCs present.

The Cohansey Yellow Clay Member is present beneath the entire Filtercake Disposal Area. The top of the unit ranges in depth from 30 to 40 feet BLS. The clay ranges up to 15 feet thick and supports several feet of perched groundwater. It should be noted that the clay formation thickness includes some thin sand/clay interfingering. Chemical analyses of soils data from the clay indicates the clay is relatively free of COCs. This is true even beneath the Trench Disposal Area. This may be due to the fact that clay/sand interfingering is much less pronounced at the Filtercake Disposal Area than at the Drum Disposal Area/Standpipe Burner Area.

Immediately eastward of the Filtercake Disposal Area, the clay surface dips below the elevation of the regional groundwater surface of the Primary Cohansey aquifer and thus the perched water resting on the clay intercepts the Primary Cohansey aquifer. The regional groundwater surface of the Primary Cohansey occurs at an depth of approximately 38 to 39 feet BLS with easterly flow. The top of the Cohansey/Kirkwood Transition Member occurs at an approximate depth of 85 feet BLS beneath the Filtercake Disposal Area. The Cohansey/Kirkwood Transition Member separates the Primary Cohansey groundwater from lower water-bearing geological units.

3.4.3.2.2 Statistical Characterization

A statistical summary of the sample data is presented in Table 3-3. The major COCs present in this area are chlorobenzene, naphthalene, nitrobenzene, 1,2,4-trichlorobenzene and mercury.

TABLE 3-3

Statistical Summary for the Filtercake Disposal Area

Chemical Of Concern	N	Mean (ppm)	50 th (ppm)	70 th (ppm)	95 th (ppm)
1,2,3-Trichloropropane	526	0.412	0.01(nd)	0.01(nd)	0.56
1,2,4-Trichlorobenzene	549	31.667	0.01(nd)	0.06	11.97
1,2- Dichlorobenzene	549	2.449	0.01(nd)	0.08	4.77
2-Chlorotoluene	522	0.386	0.01(nd)	0.01(nd)	0.34
Chlorobenzene	551	126.253	0.01(nd)	0.03	1.51
Naphthalene	548	130.017	0.01(nd)	0.05	4.19
Nitrobenzene	548	38.029	0.01(nd)	0.07	2.15
Tetrachloroethene	551	0.627	0.01(nd)	0.01(nd)	1.26
Trichloroethene	550	0.764	0.01(nd)	0.01(nd)	0.18
Mercury (subsurface)	45	375.74	98.0	206	563.20

Notes:

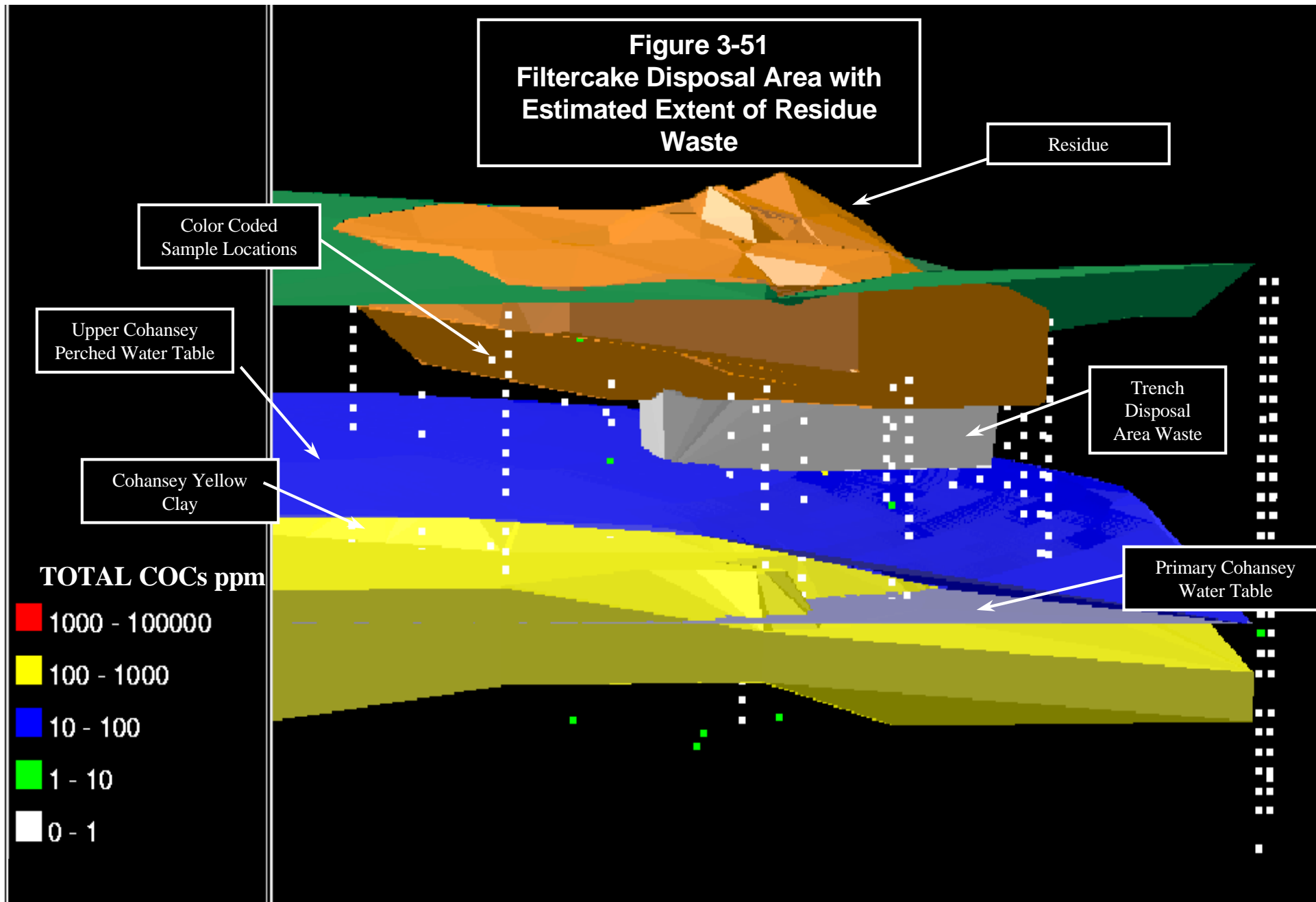
N = Number of samples

Mean = Arithmetic average concentration

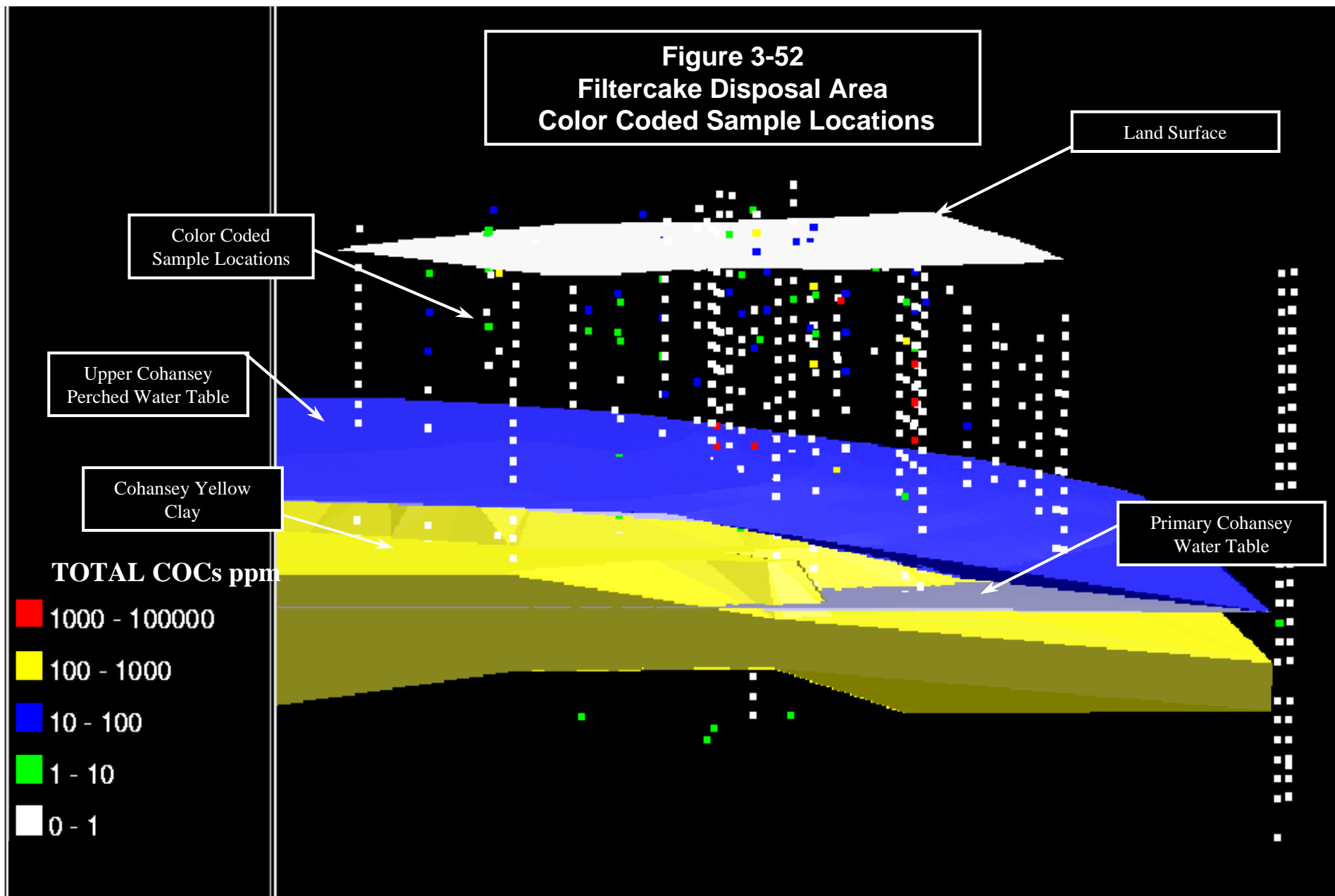
50th = For the data set, 50% of values were below and 50% of the values were above this concentration

70th = For the data set, 70% of values were below and 30% of the values were above this concentration

95th = For the data set, 95% of values were below and 5% of the values were above this concentration



Fcd -all_sam_w res



FCD_all_sam_no residue

3.4.3.3 Old Wastewater Treatment Plant Area

3.4.3.3.1 Conceptual Model

Figure 3-53 presents the conceptual model for the Old Wastewater Treatment Plant Area. The conceptual model depicts the local geology, local hydrogeology and contaminant distribution in the subsurface (i.e., location of contamination with respect to water table and geological layers). As shown on Table 3-1, the source area designation “Old Wastewater Treatment Plant Area” is comprised of the Old Wastewater Treatment Plant Area/Old Oxidation Lagoon and the Overflow Basin. The plan view locations and a description of the wastewater treatment plant operations associated with these areas were provided in Sections 2.2.4.1 and 2.2.4.5, respectively.

As can be seen by examining Figure 3-53, there are essentially no COCs present in this area. The Cohansey Yellow Clay Member is present beneath only the southern portion of this area. Where present, the clay ranges up to 7 feet thick and supports several feet of perched groundwater. It should be noted that the clay formation thickness includes some thin sand/clay interfingering.

The regional groundwater table, in the Primary Cohansey, occurs at elevations ranging from 26 feet BLS in the western portion to 30 feet BLS in the eastern portion of this area. The top of the Cohansey/Kirkwood Transition Member occurs at an approximate depth of 65 to 70 feet BLS beneath this source area. The Cohansey/Kirkwood Transition Member separates the Primary Cohansey groundwater from lower water-bearing geological units.

3.4.3.3.2 Statistical Characterization

There have been 19 subsurface borings conducted in the Old Wastewater Treatment Plant Area. Approximately 150 samples (50 chemical samples and 100 NAPL field screening samples) have been collected and analyzed to characterize this source area. A statistical summary of the Old Wastewater Treatment Plant Area sample data is presented in Table 3-4. It is estimated that there are approximately 11 pounds of COCs present in this source area.

TABLE 3-4

Statistical Summary for the Old Wastewater Treatment Plant Area

Chemical of Concern	N	Mean (ppm)	50th (ppm)	70th (ppm)	95th (ppm)
1,2,3-Trichloropropane	122	0.021	0.01(nd)	0.01(nd)	0.01(nd)
1,2,4-Trichlorobenzene	151	0.049	0.01(nd)	0.01(nd)	0.178(nd)
1,2- Dichlorobenzene	151	0.045	0.01(nd)	0.01(nd)	0.175(nd)
2-Chlorotoluene	122	0.012	0.01(nd)	0.01(nd)	0.01(nd)
Chlorobenzene	151	0.012	0.01(nd)	0.01(nd)	0.01(nd)
Naphthalene	151	0.042	0.01(nd)	0.01(nd)	0.175(nd)
Nitrobenzene	151	0.042	0.01(nd)	0.01(nd)	0.175(nd)
Tetrachloroethene	151	0.011	0.01(nd)	0.01(nd)	0.01(nd)
Trichloroethene	151	0.011	0.01(nd)	0.01(nd)	0.01(nd)

Notes:

N = Number of samples

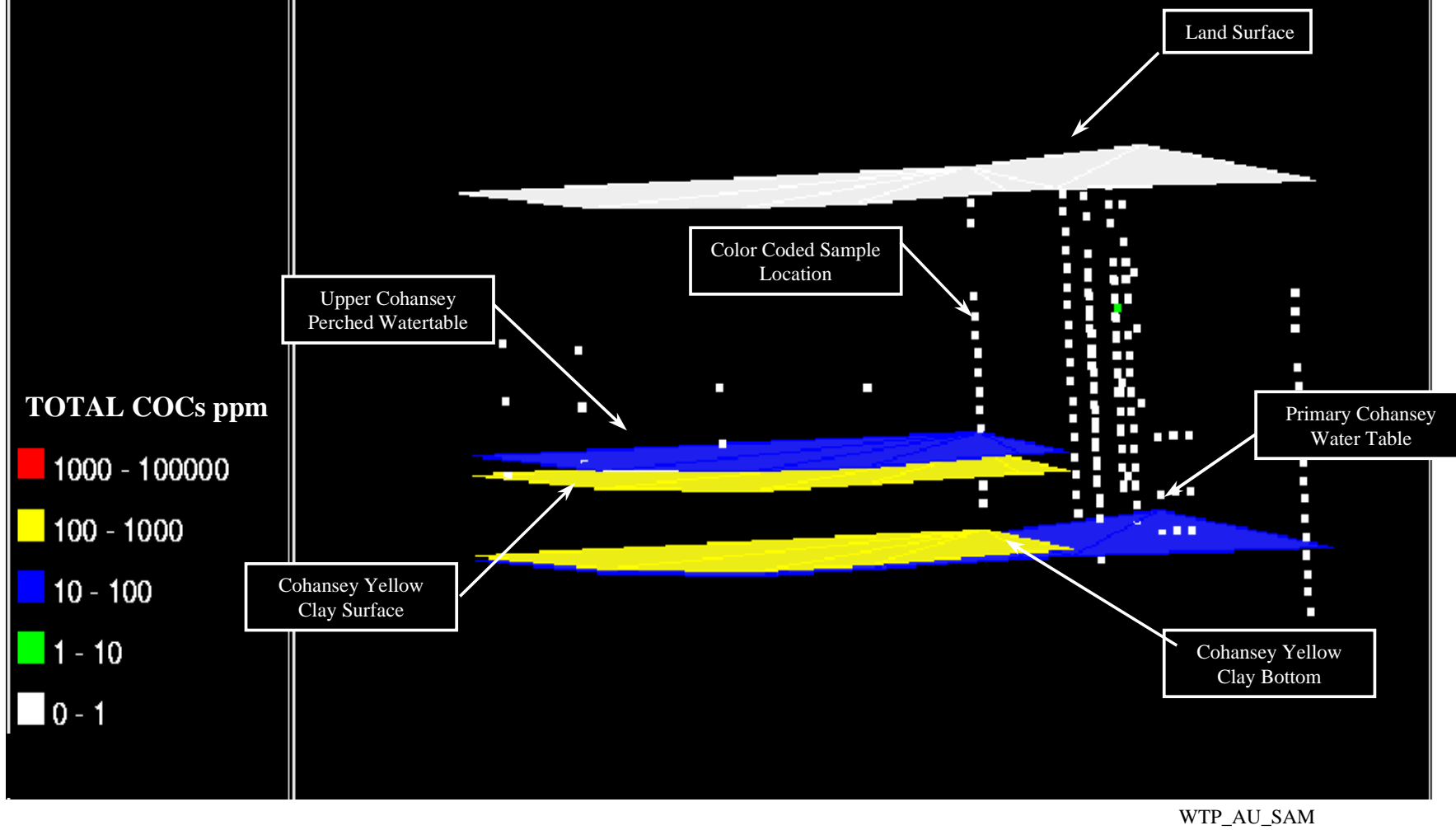
Mean = Arithmetic average concentration

50th = For the data set, 50% of values were below and 50% of the values were above this concentration

70th = For the data set, 70% of values were below and 30% of the values were above this concentration

95th = For the data set, 95% of values were below and 5% of the values were above this concentration

Figure 3-53
Old Wastewater Treatment Plant Area



3.4.3.4 Lime Sludge Disposal Area

3.4.3.4.1 Conceptual Model

Figures 3-54 and 3-55 present the conceptual model for the Lime Sludge Disposal Area. The conceptual model depicts the local geology, local hydrogeology and contaminant distribution in the subsurface (i.e., location of contamination with respect to water table and geological layers). Figure 3-54 shows the conceptual model with chemical residue present. In Figure 3-55, the residue has been stripped away to facilitate viewing all samples. The plan view location and waste disposal history for the Lime Sludge Disposal Area was provided in Section 2.2.5.2.

The unsaturated zone extends from land surface to perched water. Depending on seasonal fluctuations, it is approximately 16 to 18 feet from land surface to perched groundwater of the Upper Cohansey. The main COC in the unsaturated zone is arsenic. The presence of arsenic is limited to the chemical residue material shown on Figure 3-54. Analyses for arsenic in soils from beneath the residue indicate that arsenic is not migrating from the residue material. This is because the area is capped to prevent appreciable quantities of leachate from forming. It is also related to the inherent nature of the residue. The process that created the residue was a stabilization process. Stabilization processes are designed to prevent dissolution. Material such as arsenic that has been subjected to a stabilization process will typically not leach, even in the absence of a cap.

The thickness of groundwater varies depending on seasonal fluctuations but is often in the vicinity of approximately several feet thick. As shown on the figure, the Upper Cohansey perched groundwater is supported by the Cohansey Yellow Clay. The Cohansey Yellow Clay Member is present beneath the entire Lime Sludge Disposal Area. The top of the unit ranges in depth from 26 to 34 feet BLS. Where present, the clay is up to 14 feet thick. It should be noted that the clay formation thickness includes some thin sand/clay interfingering. Where this exists, the sand stringers may provide a pathway for limited perched groundwater movement to occur through the clay unit.

The regional groundwater table occurs at depths ranging from 39 feet BLS in the western portion to 40 feet BLS in the eastern portion of the area. The top of the Cohansey/Kirkwood Transition Member occurs at an approximate elevation of 80 to 85 feet BLS beneath this source area. The

Cohansey/Kirkwood Transition Member separates the Primary Cohansey groundwater from lower water-bearing geological units.

3.4.3.4.2 Statistical Characterization

There have been 22 subsurface borings conducted at the Lime Sludge Disposal Area. Nearly 200 chemical samples and NAPL screening samples were analyzed to characterize this source area.

A statistical summary for the sample data is presented in Table 3-5. As shown on the table, arsenic is by far the major COC present.

TABLE 3-5

Statistical Summary for the Lime Sludge Disposal Area

Chemical of Concern	N	Mean (ppm)	50th (ppm)	70th (ppm)	95th (ppm)
1,2,3-Trichloropropane	161	0.039	0.01(nd)	0.01(nd)	0.23
1,2,4-Trichlorobenzene	171	0.070	0.01(nd)	0.01(nd)	0.33
1,2- Dichlorobenzene	171	0.071	0.01(nd)	0.01(nd)	0.33
2-Chlorotoluene	162	0.018	0.01(nd)	0.01(nd)	0.05
Chlorobenzene	171	0.020	0.01(nd)	0.01(nd)	0.09
Naphthalene	171	0.068	0.01(nd)	0.01(nd)	0.30
Nitrobenzene	171	0.068	0.01(nd)	0.01(nd)	0.31
Tetrachloroethene	171	0.017	0.01(nd)	0.01(nd)	0.05
Trichloroethene	171	0.019	0.01(nd)	0.01(nd)	0.07
Arsenic	23	48,768	6800	57,540	198,900

Notes:

N = Number of samples

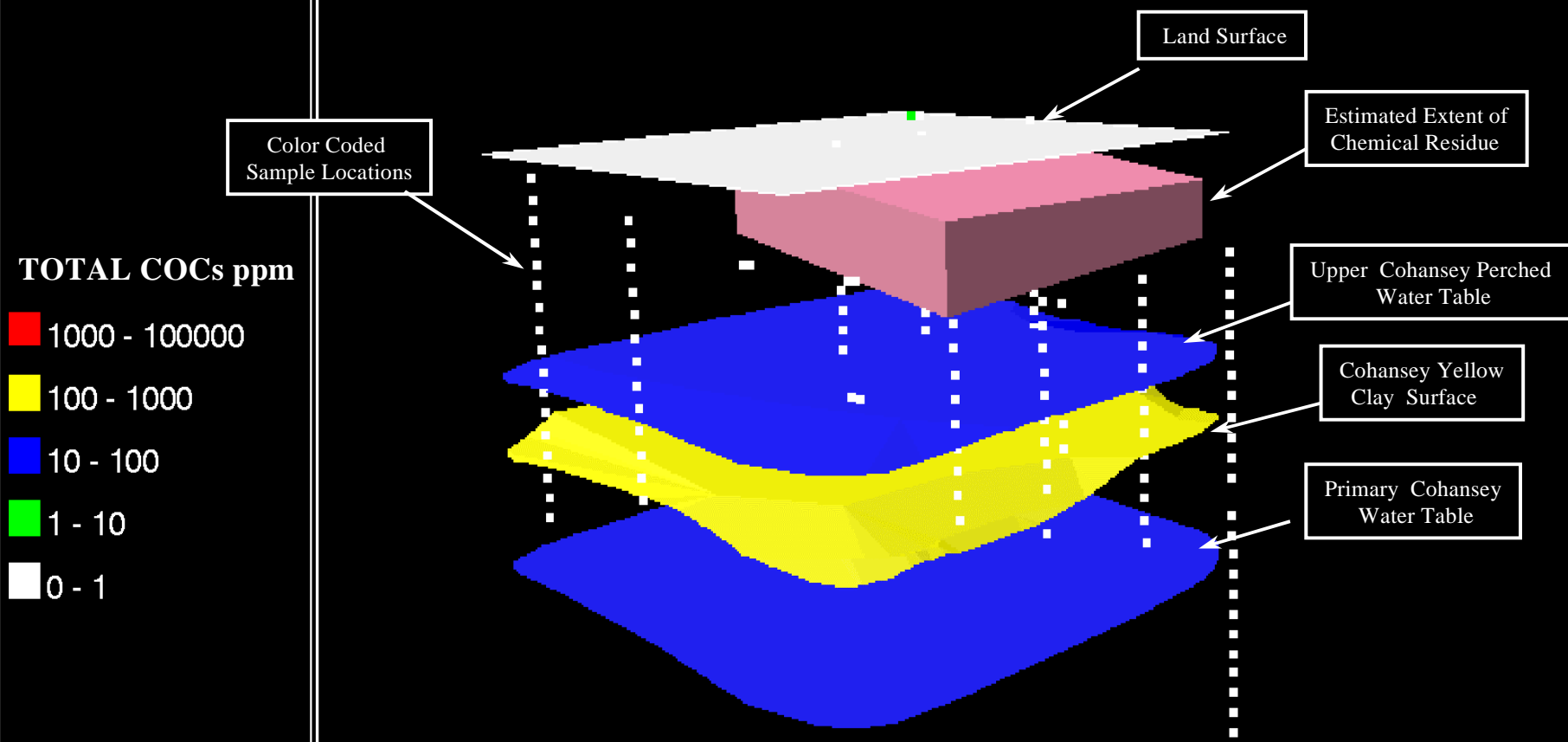
Mean = Arithmetic average concentration

50th = For the data set, 50% of values were below and 50% of the values were above this concentration

70th = For the data set, 70% of values were below and 30% of the values were above this concentration

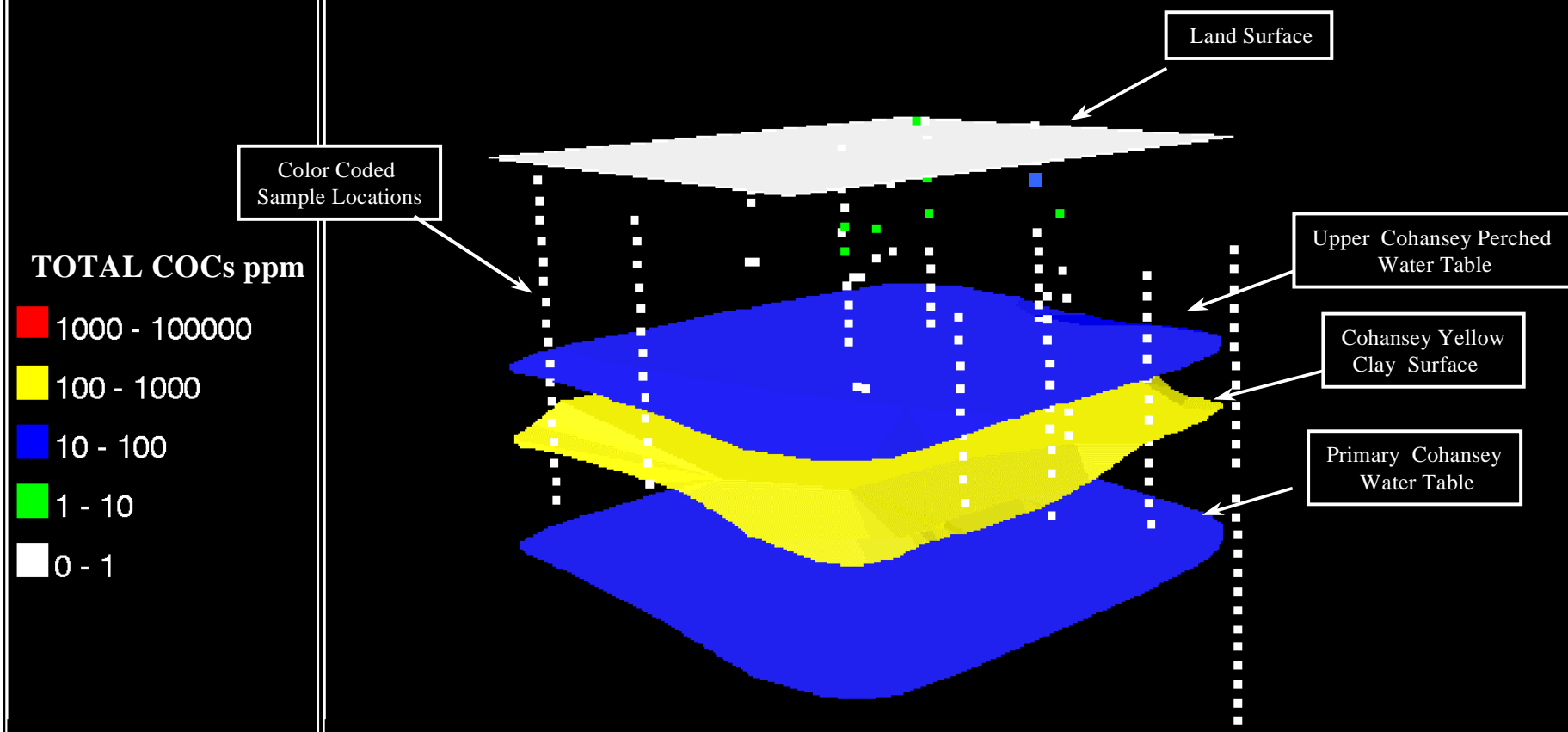
95th = For the data set, 95% of values were below and 5% of the values were above this concentration

Figure 3-54
Lime Sludge Disposal Area Sample Locations
With Estimated Extent of Chemical Residue



lsd all sam w residue.ps

Figure 3-55
Lime Sludge Disposal Area
Color Coded Sample Locations



lsd all sam no residue.ps

3.4.3.5 Equalization Basins

3.4.3.5.1 Conceptual Model

Figure 3-56 presents the conceptual model for the Equalization Basins. The conceptual model depicts the local geology, local hydrogeology and contaminant distribution in the subsurface (i.e., location of contamination with respect to water table and geological layers). As shown on Table 3-1, the East and West Equalization Basins are designated as the Equalization Basins. The plan view locations and a description of the wastewater treatment plant operations associated with the Equalization Basins was provided in Section 2.2.4.2.

The Cohansey Yellow Clay Member is absent beneath the Equalization Basins, so no perched groundwater exists and the unsaturated zone extends from land surface down to the groundwater surface of the Primary Cohansey. Chemically, the unsaturated zones of the east and west basins are similar with 1,2,4-trichlorobenzene and 1,2-dichlorobenzene serving as major COCs representative of each basin. The unsaturated zones differ in their 2-chlorotoluene content; the west basin contains substantial quantities of 2-chlorotoluene whereas the eastern basin contains little 2-chlorotoluene.

The surface of the Primary Cohansey occurs at elevations ranging from 25 feet BLS in the western portion to 29 feet BLS in the eastern portion. The aquifer extends downward to the top of the Cohansey/Kirkwood Transition zone. The saturated zone beneath the area mirrors the chemical profile of the unsaturated zone. 1,2,4-trichlorobenzene and 1,2-dichlorobenzene are present as major COCs in each basin. 2-chlorotoluene is present in the west but is generally absent from the east.

The top of the Cohansey/Kirkwood Transition Member occurs at an approximate depth of 65 feet BLS beneath the EQ basins. The Cohansey/Kirkwood Transition Member separates the Primary Cohansey groundwater from lower water-bearing geological units.

3.4.3.5.2 Statistical Characterization

The Equalization Basins have been subjected to extensive characterization. There have been over 140 subsurface borings in the basins. Over 1400 samples have been analyzed to characterize the basins, which includes 300 chemical samples and 1,100 NAPL field screening samples.

A statistical summary of the sample data for the Equalization Basins is presented below in Table 3-6. The major COCs present in the Equalization Basins are 1,2,4-trichlorobenzene, 2-chlorotoluene and 1,2-dichlorobenzene. Generally, it can be said that there is more COC mass present in the west basin than the east basin. Also, most COC mass resides in the vadose zone rather than the saturated zone.

TABLE 3-6**Statistical Summary for the Equalization Basins**

Chemical of Concern	N	Mean (ppm)	50th (ppm)	70th (ppm)	95th (ppm)
1,2,3-Trichloropropane	1023	0.125	0.01(nd)	0.01(nd)	0.33
1,2,4-Trichlorobenzene	1224	53.77	0.01(nd)	0.039	44.25
1,2- Dichlorobenzene	1223	21.28	0.01(nd)	0.017	21.9
2-Chlorotoluene	1047	44.11	0.01(nd)	0.01(nd)	0.61
Chlorobenzene	1216	2.79	0.01(nd)	0.01(nd)	3.09
Naphthalene	1207	1.28	0.01(nd)	0.013	1.60
Nitrobenzene	1205	3.85	0.01(nd)	0.032	3.91
Tetrachloroethene	1207	1.37	0.01(nd)	0.01(nd)	0.65
Trichloroethene	1205	0.17	0.01(nd)	0.01(nd)	0.65

Notes:

N = Number of samples

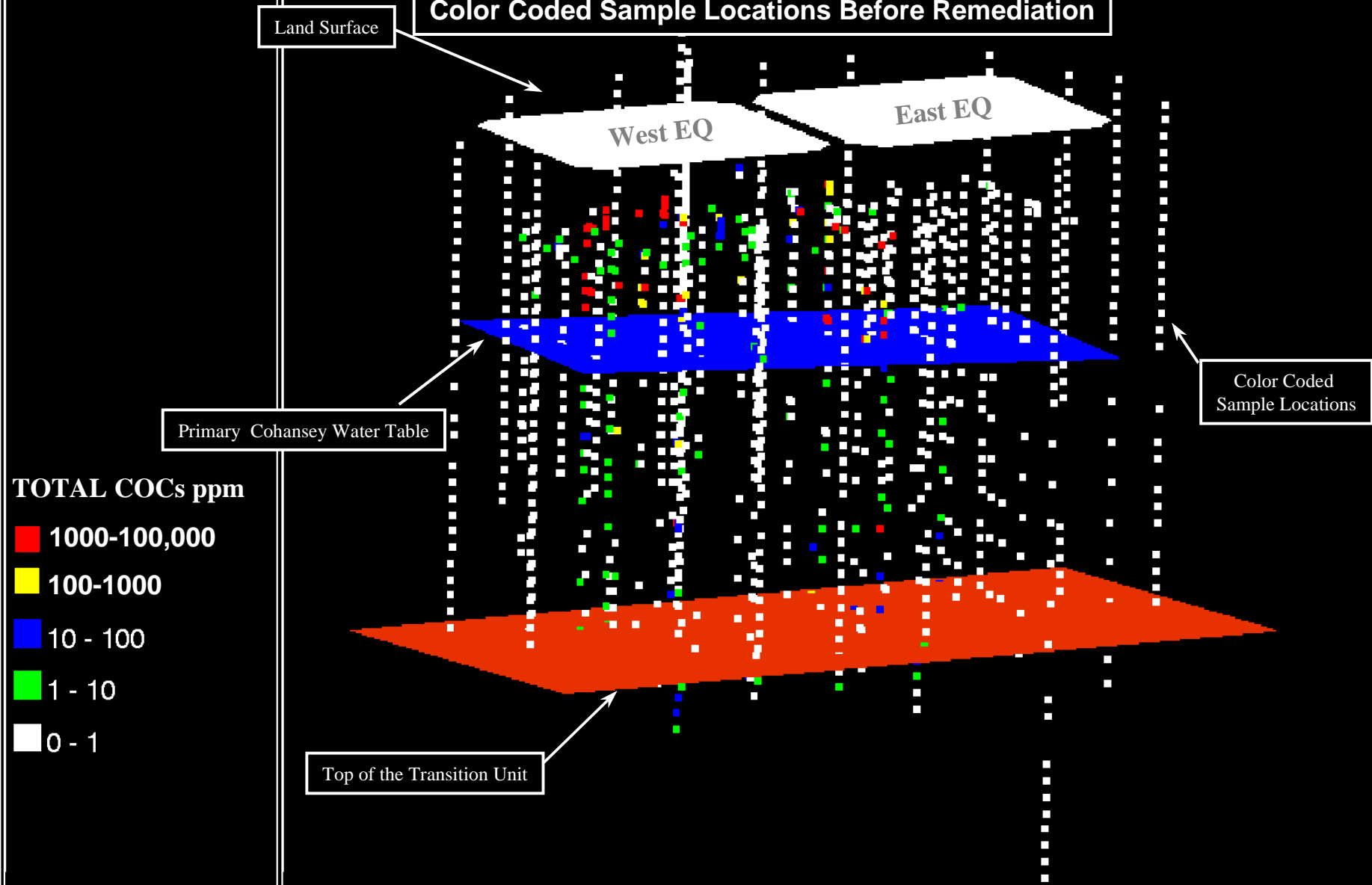
Mean = Arithmetic average concentration

50th = For the data set, 50% of values were below and 50% of the values were above this concentration

70th = For the data set, 70% of values were below and 30% of the values were above this concentration

95th = For the data set, 95% of values were below and 5% of the values were above this concentration

Figure 3-56
Equalization Basins
Color Coded Sample Locations Before Remediation



eq_sam.ps

3.4.3.6 Backfilled Lagoon Area

3.4.3.6.1 Conceptual Model

Figures 3-57 and 3-58 present the conceptual model for the Backfilled Lagoon Area. The conceptual model depicts the local geology, local hydrogeology and contaminant distribution in the subsurface (i.e., location of contamination with respect to water table and geological layers). Figure 3-57 shows the conceptual model with wastewater treatment residue present. In Figure 3-58, the residue has been stripped away to facilitate viewing all samples. As shown on Table 3-1, the Backfilled Lagoon Area is comprised of five treatment lagoons (the Oxidation Lagoon, Settling Lagoon, Final Polishing Lagoon, Northern Sludge Drying Lagoon and Southern Sludge Drying Lagoon) and the Ocean Outfall Basin. The plan view locations and a description of the wastewater treatment operations associated with these areas were provided in Sections 2.2.4.3 and 2.2.2.4.

The Cohansey Yellow Clay Member is absent beneath this source area, so no perched groundwater exists and the unsaturated zone extends to the top of the Primary Cohansey aquifer. Two (2) of the Backfilled Lagoon Area subareas (the Northern and Southern Sludge Drying Lagoons) have a nearly continuous layer of sludge material approximately 2 to 4 feet below ground surface, ranging in thickness from 3 to 9 feet. Both of these are pictured on Figure 3-57. Three (3) of the Backfilled Lagoon Area subareas (the Oxidation Lagoon, Settling Lagoon and Final Polishing Pond) have occasional lenses of sludge material mixed with low level soil contamination and are therefore not pictured on the figure. All residue material resides in the unsaturated zone. An examination of the figures reveals that nearly all of the higher level contamination in the area is within the residue material of the two northern lagoons (Northern Sludge Drying Lagoon and Southern Sludge Drying Lagoon). The main organic COCs are 1,2,4-trichlorobenzene, 2-chlorotoluene and naphthalene. Lead is an area-specific inorganic COC for the area and is found at moderately high concentrations in the unsaturated zone.

The regional groundwater table of the Primary Cohansey occurs at depths ranging from 15.5 feet BLS to 21 feet BLS. Only low level COC concentrations are found in the saturated zone. The top of the Cohansey/Kirkwood Transition Member occurs at an approximate depth of 35 to 40 feet BLS beneath this source area. The Cohansey/Kirkwood Transition Member separates the Primary Cohansey groundwater from lower water-bearing geological units.

3.4.3.6.2 Statistical Characterization

There have been over 100 subsurface borings conducted in the Backfilled Lagoon Area. Over 200 samples have been collected, which include 100 chemical samples and 100 NAPL field screening samples. A statistical summary of the sample data is presented in Table 3-7.

TABLE 3-7

Statistical Summary for the Backfilled Lagoon Area

Chemical of Concern	N	Mean (ppm)	50th (ppm)	70th (ppm)	95th (ppm)
1,2,3-Trichloropropane	175	0.378	0.01(nd)	0.219	2.745
1,2,4-Trichlorobenzene	237	16.065	0.024	0.195	60.862
1,2- Dichlorobenzene	233	2.374	0.014	0.190	13.4
2-Chlorotoluene	176	9.391	0.01(nd)	0.051	56.892
Chlorobenzene	241	0.698	0.01(nd)	0.086	2.900
Naphthalene	234	4.060	0.022	0.186	25.177
Nitrobenzene	225	0.308	0.016	0.165	1.421
Tetrachloroethene	238	0.108	0.01(nd)	0.051	0.591
Trichloroethene	238	0.126	0.01(nd)	0.066	0.764
Lead	51	127.149	4.7	88.00	533.00

Notes:

N = Number of samples

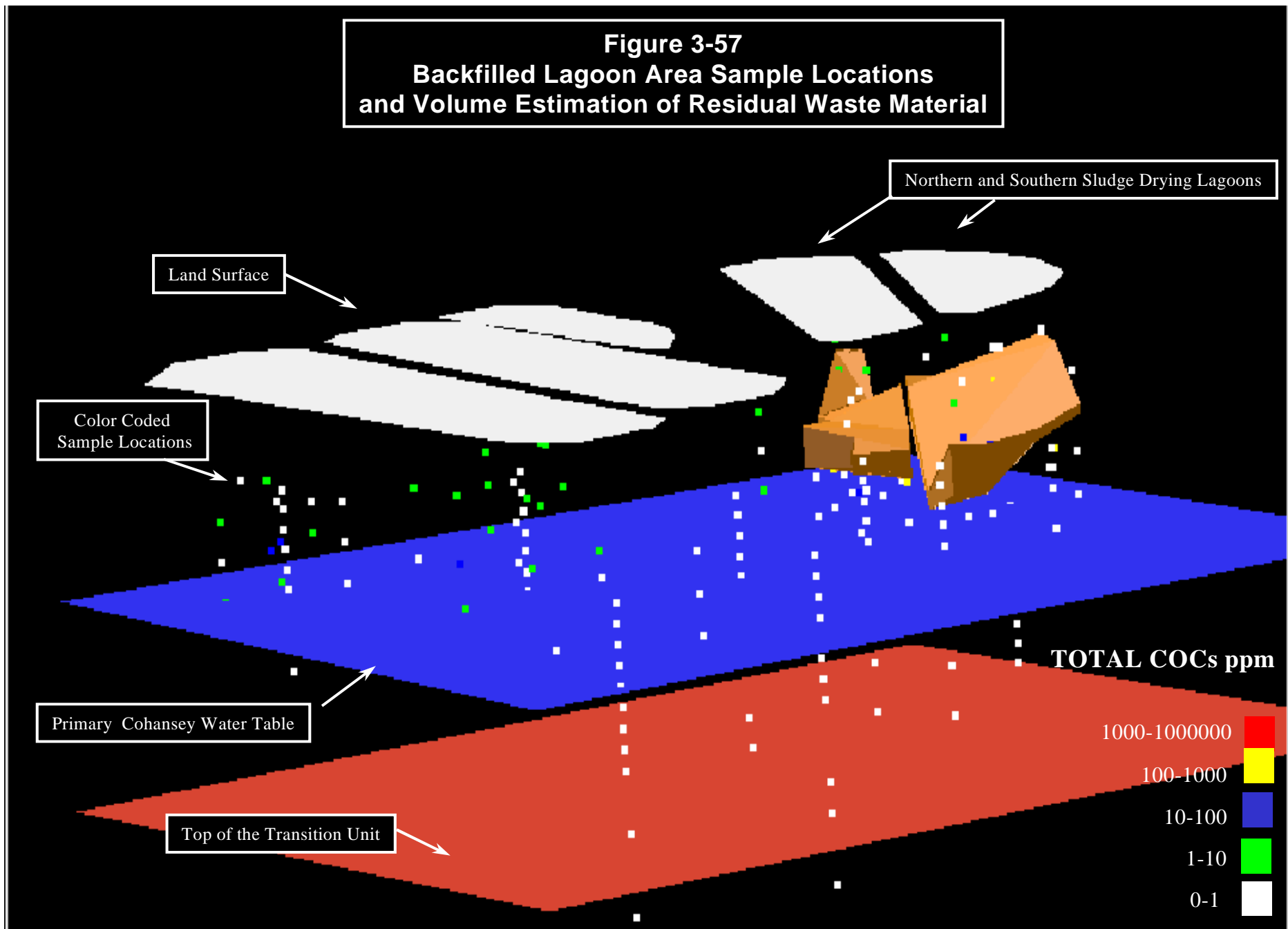
Mean = Arithmetic average concentration

50th = For the data set, 50% of values were below and 50% of the values were above this concentration

70th = For the data set, 70% of values were below and 30% of the values were above this concentration

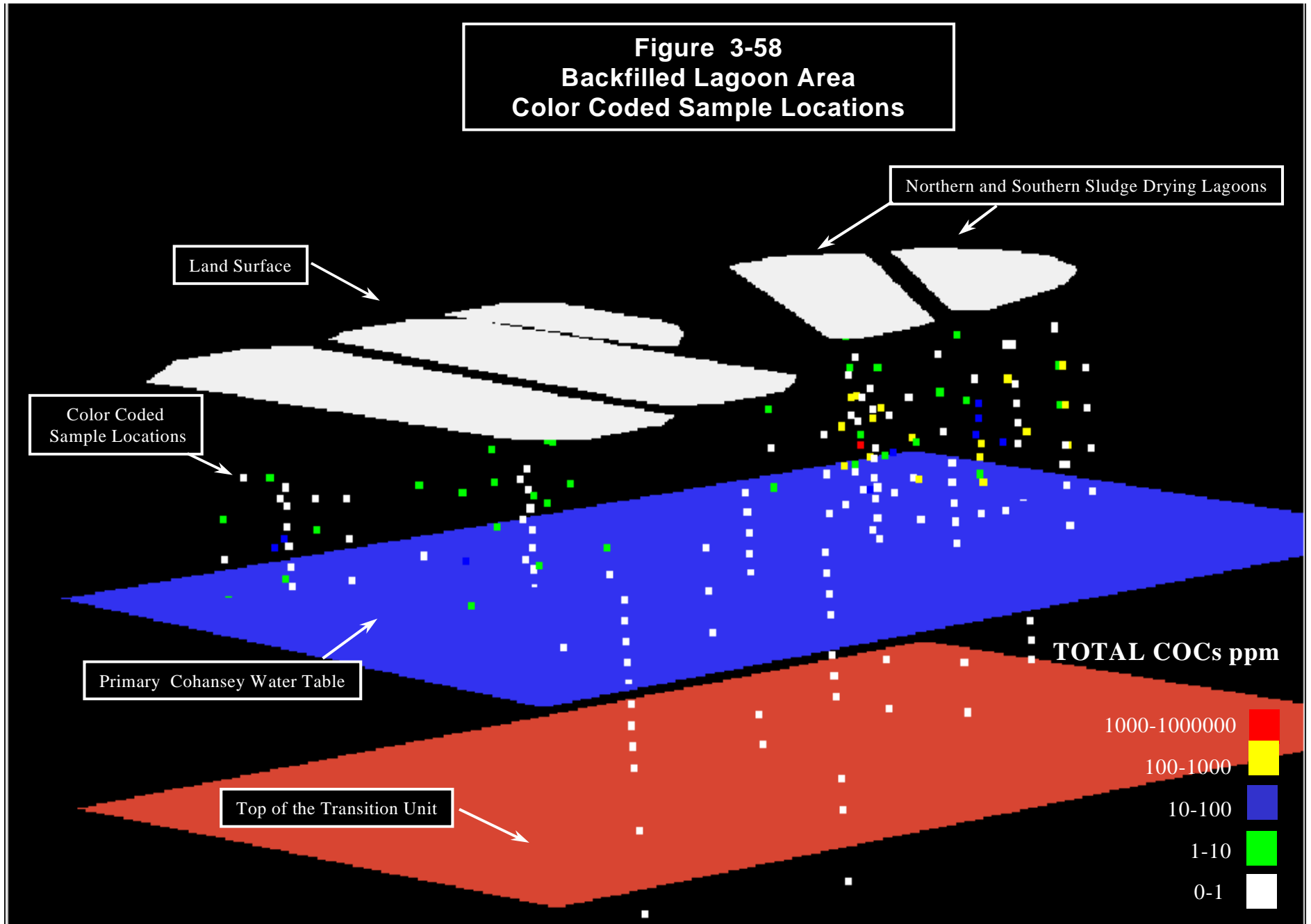
95th = For the data set, 95% of values were below and 5% of the values were above this concentration

Figure 3-57
Backfilled Lagoon Area Sample Locations
and Volume Estimation of Residual Waste Material



bla_all sam w residual .ps

Figure 3-58
Backfilled Lagoon Area
Color Coded Sample Locations



bla_all sam .ps

3.4.3.7 Former South Dye Area

3.4.3.7.1 Conceptual Model

Figure 3-59 presents the conceptual model for the Former South Dye Area. The conceptual model depicts the local geology, local hydrogeology and contaminant distribution in the subsurface (i.e., location of contamination with respect to water table and geological layers). The plan view location and production activities associated with the Former South Dye Area was presented in Section 2.2.6.1.

The unsaturated zone extends approximately 20 to 25 feet downward from land surface to the top of the upper Cohansey perched water zone. An examination of Figure 3-59 shows that most unsaturated zone contamination is located on one end (west end) of the Former South Dye Area. The main contaminants present in the unsaturated zone consist of 1,2-dichlorobenzene, 1,2,4-trichlorobenzene and 2-chlorotoluene.

The Upper Cohansey saturated zone consists of several feet of saturated sand supported by the Cohansey Yellow Clay. The higher contamination levels in the perched zone is focused in the western end of the area and is found at lower levels across much of the zone. The main contaminants present in the saturated zone consist of the same one found in the unsaturated zone (i.e., 1,2-dichlorobenzene, 1,2,4-trichlorobenzene and 2-chlorotoluene).

The Cohansey Yellow Clay Member is present beneath nearly all of the Former South Dye Area and pinches out or becomes insignificant along the southeastern portion of the area. A large portion of the clay is contaminated. This is because much of the Cohansey Yellow Clay for this area consists of thin sand/clay interfingering layers of sand and clay. Where this exists, the sand stringers have likely provided a pathway for perched groundwater movement to occur within and even through the clay unit. The clay surface generally dips toward the southeast. This causes perched water on top of the clay and water entrained within the clay to flow in a southeasterly direction, toward the edge of the clay or bottom of the clay, where it discharges into the regional groundwater table. The major contaminants are 1,2-dichlorobenzene, 1,2,4-trichlorobenzene and 2-chlorotoluene.

The regional groundwater table of the Primary Cohansey occurs at depths ranging from 31 feet BLS in the western portion to 34 feet BLS in the eastern portion of the area. The top of the Cohansey/Kirkwood

Transition Member occurs at an approximate depth of 65 to 70 feet BLS beneath the Former South Dye Area. The Cohansey/Kirkwood Transition Member separates the Primary Cohansey groundwater from lower water-bearing geological units.

3.4.3.7.2 Statistical Characterization

There have been over 100 subsurface borings conducted in the Former South Dye Area. This source area has been characterized based on over 1,000 samples, which include nearly 300 chemical samples and over 700 NAPL field screening samples. A statistical summary of the sample data is presented in Table 3-8.

TABLE 3-8

Statistical Summary for the Former South Dye Area

Chemical of Concern	N	Mean (ppm)	50 th (ppm)	70 th (ppm)	95 th (ppm)
1,2,3-Trichloropropane	949	0.310	0.01(nd)	0.210	1.50
1,2,4-Trichlorobenzene	1060	27.157	0.01(nd)	0.190	120.000
1,2- Dichlorobenzene	1079	65.744	0.01(nd)	0.102	52.10
2-Chlorotoluene	982	23.439	0.01(nd)	0.054(nd)	54.00
Chlorobenzene	1070	2.001	0.01(nd)	0.081(nd)	2.90
Naphthalene	1034	1.045	0.01(nd)	0.075(nd)	2.70
Nitrobenzene	868	2.190	0.01(nd)	0.046(nd)	0.50
Tetrachloroethene	1057	0.198	0.01(nd)	0.049(nd)	0.85
Trichloroethene	1060	0.208	0.01(nd)	0.063	0.85

Notes:

N = Number of samples

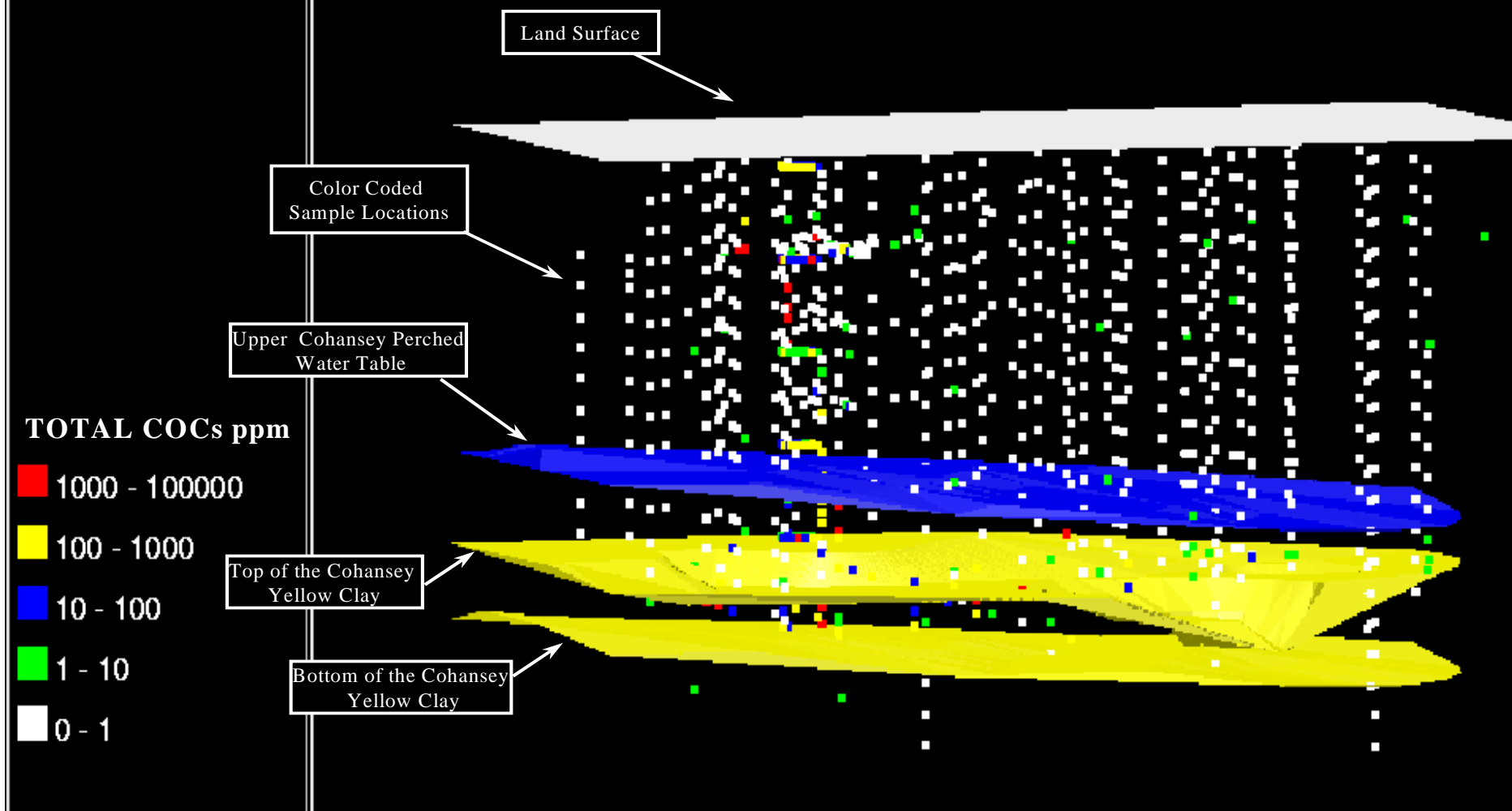
Mean = Arithmetic average concentration

50th = For the data set, 50% of values were below and 50% of the values were above this concentration

70th = For the data set, 70% of values were below and 30% of the values were above this concentration

95th = For the data set, 95% of values were below and 5% of the values were above this concentration

Figure 3-59
Former South Dye Area
Color Coded Sample Locations



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3.4.3.8 East Overflow Area

3.4.3.8.1 Conceptual Model

Figure 3-60 presents the conceptual model for the East Overflow Area. The conceptual model depicts the local geology, local hydrogeology and contaminant distribution in the subsurface (i.e., location of contamination with respect to water table and geological layers). The plan view location and history of the East Overflow Area was presented in Section 2.2.4.6.

The Cohansey Yellow Clay Member is present beneath only a small portion of the East Overflow Area. The regional groundwater table occurs at a depth of about 30 feet BLS with east to southeasterly flow. The top of the Cohansey/Kirkwood Transition Member occurs at an approximate depth of 60 feet BLS beneath this source area. The Cohansey/Kirkwood Transition Member separates the Primary Cohansey groundwater from lower water-bearing geological units. Analyses of soil samples did not reveal the presence of COCs in the area.

3.4.3.8.2 Statistical Characterization

A total of four (4) subsurface borings were conducted in the East Overflow Area. Seven (7) samples were chemically analyzed to characterize this source area. A statistical summary of the sample data is presented in Table 3-9. The concentrations of COCs associated with the East Overflow Area correspond to less than one (1) pound of total COCs.

TABLE 3-9

Statistical Summary for the East Overflow Area

Chemicals of Concern	N	Mean (ppm)	50 th (ppm)	70 th (ppm)	95 th (ppm)
1,2,3-Trichloropropane	0				
1,2,4-Trichlorobenzene	7	0.181	0.175(nd)	0.183(nd)	0.195(nd)
1,2- Dichlorobenzene	7	0.181	0.175(nd)	0.183(nd)	0.195(nd)
2-Chlorotoluene	0				
Chlorobenzene	7	0.003	0.002(nd)	0.003(nd)	0.003(nd)
Naphthalene	7	0.183	0.175(nd)	0.183(nd)	0.195(nd)
Nitrobenzene	7	0.181	0.175(nd)	0.183(nd)	0.195(nd)
Tetrachloroethene	7	0.003	0.003(nd)	0.003(nd)	0.003(nd)
Trichloroethene	7	0.003	0.003(nd)	0.003(nd)	0.003(nd)

Notes:

N = Number of samples

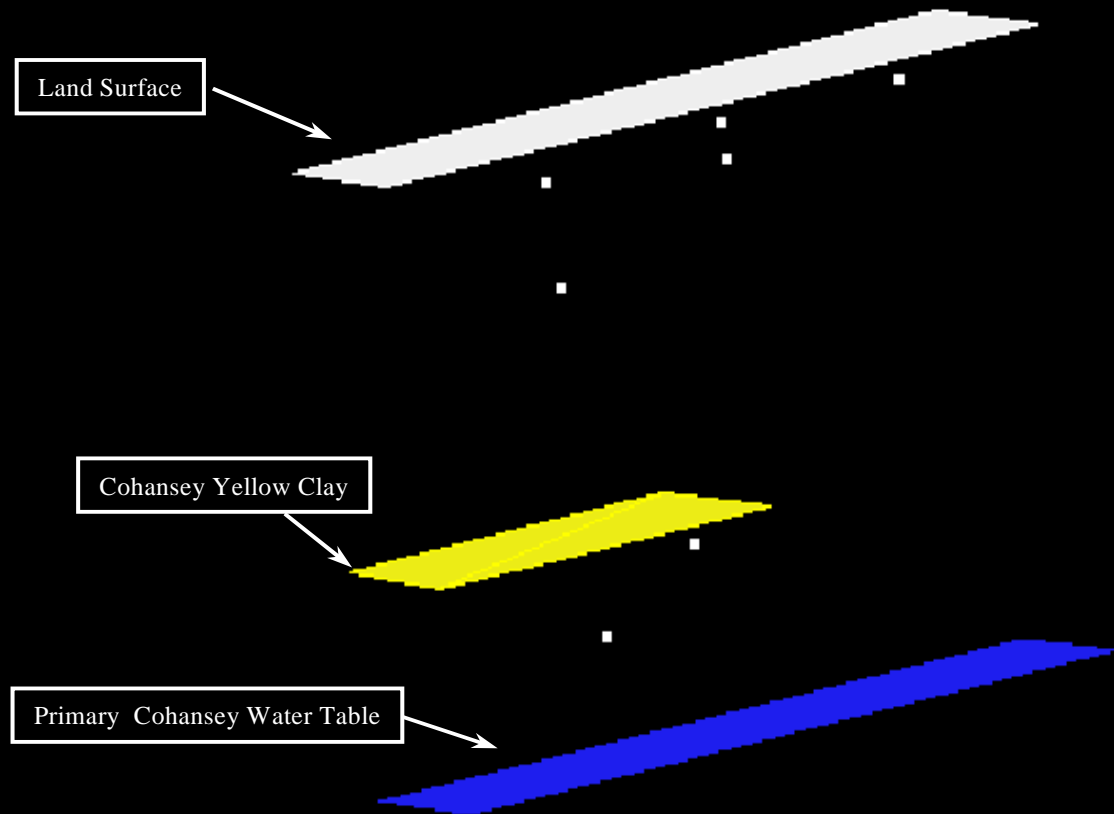
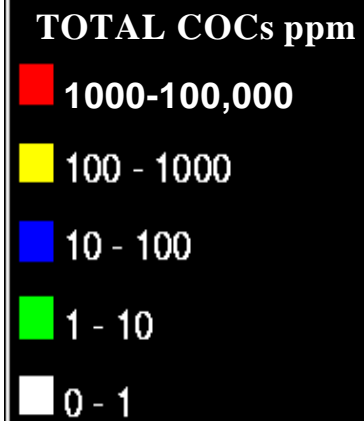
Mean = Arithmetic average concentration

50th = For the data set, 50% of values were below and 50% of the values were above this concentration

70th = For the data set, 70% of values were below and 30% of the values were above this concentration

95th = For the data set, 95% of values were below and 5% of the values were above this concentration

Figure 3-60
East Overflow Area
Color Coded Sample Locations



eoal all sam.ps

3.4.3.9 Borrow Compactor Area

3.4.3.9.1 Conceptual Model

Figure 3-61 presents the conceptual model for the Borrow Compactor Area. The conceptual model depicts the local geology, local hydrogeology and contaminant distribution in the subsurface (i.e., location of contamination with respect to water table and geological layers). The plan view location and historical use of the Borrow Compactor Area was presented in Section 2.2.5.6.

The Cohansey Yellow Clay Member is absent beneath the Borrow Compactor Area, so no perched groundwater exists. Also, at this northerly location of the site, the Cohansey/Kirkwood Transitional Member becomes indistinguishable from the overlying Primary Cohansey Sand and underlying Lower Cohansey Sand Members. Thus, the uppermost aquitard encountered beneath the area is the Upper Kirkwood Member. The regional groundwater table occurs at depths ranging from 20 feet BLS in the western portion to 24 feet BLS in the eastern portion of the area. The presence of COCs on the area is limited to the unsaturated zone. The main COCs present consist of are 1,2,4-trichlorobenzene and naphthalene.

3.4.3.9.2 Statistical Characterization

There have been 79 subsurface borings conducted in the Borrow Compactor Area. Over 300 samples were analyzed to chemically characterize the source area, which include nearly 200 chemical samples and over 100 NAPL field screening samples. A statistical summary of the sample data is presented in Table 3-10.

TABLE 3-10**Statistical Summary for the Borrow Compactor Area**

Chemicals of Concern	N	Mean (ppm)	50th (ppm)	70th (ppm)	95th (ppm)
1,2,3-Trichloropropane	172	0.73	0.01(nd)	0.01(nd)	0.239
1,2,4-Trichlorobenzene	220	11.082	0.01(nd)	0.170	0.550
1,2- Dichlorobenzene	220	4.708	0.01(nd)	0.170	1.050
2-Chlorotoluene	172	0.065	0.01(nd)	0.01(nd)	0.046
Chlorobenzene	221	2.321	0.01(nd)	0.01(nd)	0.295
Naphthalene	222	11.368	0.01(nd)	0.170	0.550
Nitrobenzene	219	0.341	0.01(nd)	0.170	0.550
Tetrachloroethene	219	0.318	0.01(nd)	0.01(nd)	0.296
Trichloroethene	219	3.505	0.01(nd)	0.01(nd)	0.296

Notes:

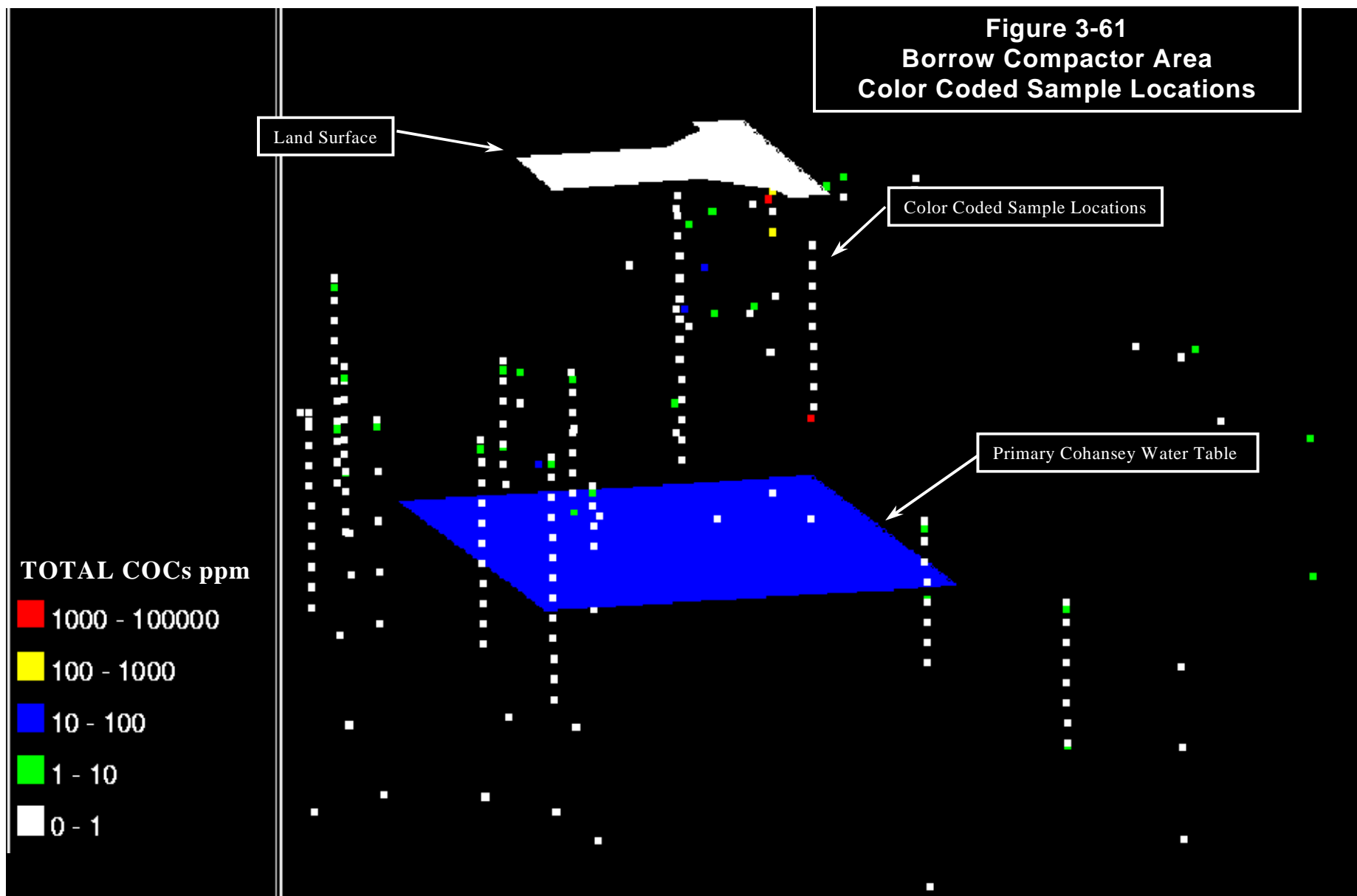
N = Number of samples

Mean = Arithmetic average concentration

50th = For the data set, 50% of values were below and 50% of the values were above this concentration

70th = For the data set, 70% of values were below and 30% of the values were above this concentration

95th = For the data set, 95% of values were below and 5% of the values were above this concentration



R_BCA_all_sam

3.4.3.10 Former Building 108/Underground Storage Tank Area

3.4.3.10.1 Conceptual Model

Figure 3-62 presents the conceptual model for the Former Building 108/Underground Storage Tank (UST) Area. The conceptual model depicts the local geology, local hydrogeology and contaminant distribution in the subsurface (i.e., location of contamination with respect to water table and geological layers). The plan view location and production activities associated with the Former Building 108/UST Area was presented in Section 2.2.6.1.

With the exception of a small lense in the extreme eastern portion of the area, the Cohansey Yellow Clay Member is absent beneath this source area and no perched groundwater exists. The regional groundwater table of the Primary Cohansey occurs at depths ranging from 35 feet BLS in the western portion to 39 feet BLS in the eastern portion. Most contamination is found in close proximity to the top of the Primary Cohansey water table. COCs in the unsaturated zone are mostly found within 5 to 10 feet above the water table. COCs in the saturated zone of the Primary Cohansey are mostly found within 5 to 10 feet below the surface of the water table.

The top of the Cohansey/Kirkwood Transition Member occurs at an approximate depth of 70 feet BLS beneath this source area. Low level concentrations of COCs are found in this member. The Cohansey/Kirkwood Transition Member separates the Primary Cohansey groundwater from lower water-bearing geological units.

3.4.3.10.2 Statistical Characterization

There have been over 50 subsurface borings conducted in the area. Nearly 1,200 samples have been collected to characterize this area. These include over 100 chemical samples and over 1,000 NAPL field screening samples. A statistical summary of the sample data is presented in Table 3-11. The primary COC is 1,2,4-trichlorobenzene.

TABLE 3-11

Statistical Summary for the Building 108/UST Area

Chemicals of Concern	N	Mean (ppm)	50th (ppm)	70th (ppm)	95th (ppm)
1,2,3-Trichloropropane	1163	0.052	0.01(nd)	0.01(nd)	0.01(nd)
1,2,4-Trichlorobenzene	1171	3.015	0.01(nd)	0.01(nd)	0.01(nd)
1,2- Dichlorobenzene	1171	0.292	0.01(nd)	0.01(nd)	0.01(nd)
2-Chlorotoluene	1163	0.011	0.01(nd)	0.01(nd)	0.01(nd)
Chlorobenzene	1171	0.076	0.01(nd)	0.01(nd)	0.01(nd)
Naphthalene	1171	0.010	0.01(nd)	0.01(nd)	0.01(nd)
Nitrobenzene	1171	0.046	0.01(nd)	0.01(nd)	0.01(nd)
Tetrachloroethene	1171	0.015	0.01(nd)	0.01(nd)	0.01(nd)
Trichloroethene	1171	0.013	0.01(nd)	0.01(nd)	0.01(nd)

Notes:

N = Number of samples

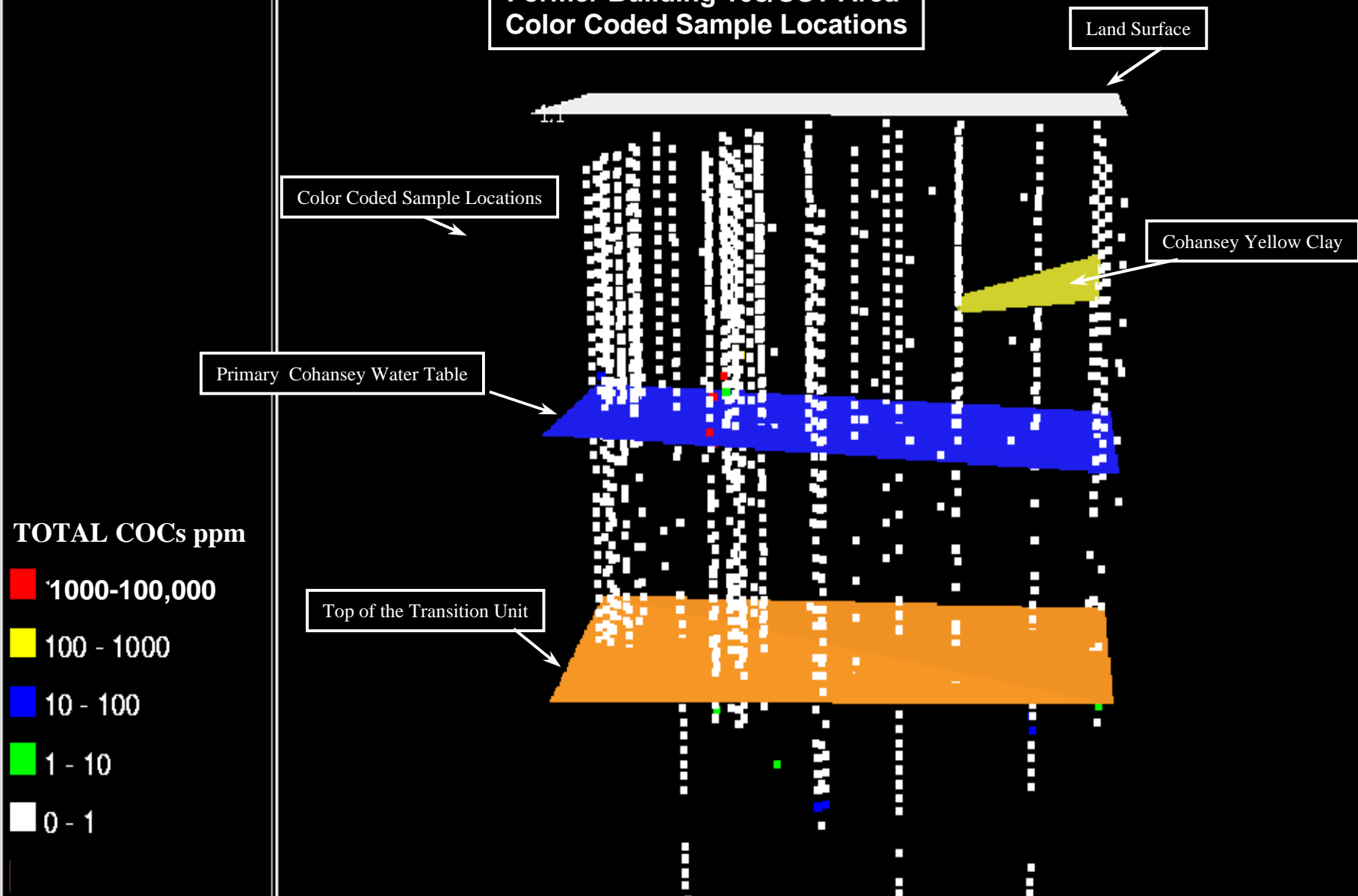
Mean = Arithmetic average concentration

50th = For the data set, 50% of values were below and 50% of the values were above this concentration

70th = For the data set, 70% of values were below and 30% of the values were above this concentration

95th = For the data set, 95% of values were below and 5% of the values were above this concentration

Figure 3-62
Former Building 108/UST Area
Color Coded Sample Locations



108 all sam .ps

3.4.3.11 Calcium Sulfate Disposal Area

3.4.3.11.1 Conceptual Model

Figure 3-63 presents the conceptual model for the Calcium Sulfate Disposal Area. The conceptual model depicts the local geology, local hydrogeology and contaminant distribution in the subsurface (i.e., location of contamination with respect to water table and geological layers). The plan view location and waste disposal history for the Calcium Sulfate Disposal Area was presented in Section 2.2.5.5.

The Cohansey Yellow Clay Member is absent beneath the Calcium Sulfate Disposal Area, so no perched groundwater exists. Only the very lowest of levels of COCs have been detected in the area. The regional groundwater table of the Primary Cohansey occurs at a depth of approximately 38 feet BLS with easterly flow. The top of the Cohansey/Kirkwood Transition Member occurs at an approximate depth of 60 to 65 feet BLS beneath this source area. The Cohansey/Kirkwood Transition Member separates the Primary Cohansey groundwater from lower water-bearing geological units.

3.4.3.11.2 Statistical Characterization

There have been three (3) subsurface borings conducted in the Calcium Sulfate Disposal Area. Thirteen (13) chemical samples were analyzed to characterize this source area. A statistical summary of the sample data is presented in Table 3-12. There are approximately three (3) pounds of COCs present in the Calcium Sulfate Disposal Area. The primary COC is nitrobenzene.

TABLE 3-12**Statistical Summary for the Calcium Sulfate Disposal Area**

Chemicals of Concern	N	Mean (ppm)	50 th Median (ppm)	70 th (ppm)	95 th (ppm)
1,2,3-Trichloropropane	0				
1,2,4-Trichlorobenzene	10	0.201	0.178(nd)	0.232(nd)	0.285(nd)
1,2- Dichlorobenzene	10	0.181	0.175(nd)	0.194(nd)	0.253(nd)
2-Chlorotoluene	0				
Chlorobenzene	7	0.004	0.004(nd)	0.004(nd)	0.005(nd)
Naphthalene	10	0.182	0.175(nd)	0.194(nd)	0.253(nd)
Nitrobenzene	10	1.011	0.307(nd)	0.759(nd)	3.830
Tetrachloroethene	7	0.004	0.004(nd)	0.004(nd)	0.005(nd)
Trichloroethene	7	0.004	0.004(nd)	0.004(nd)	0.005(nd)

Notes:

N = Number of samples

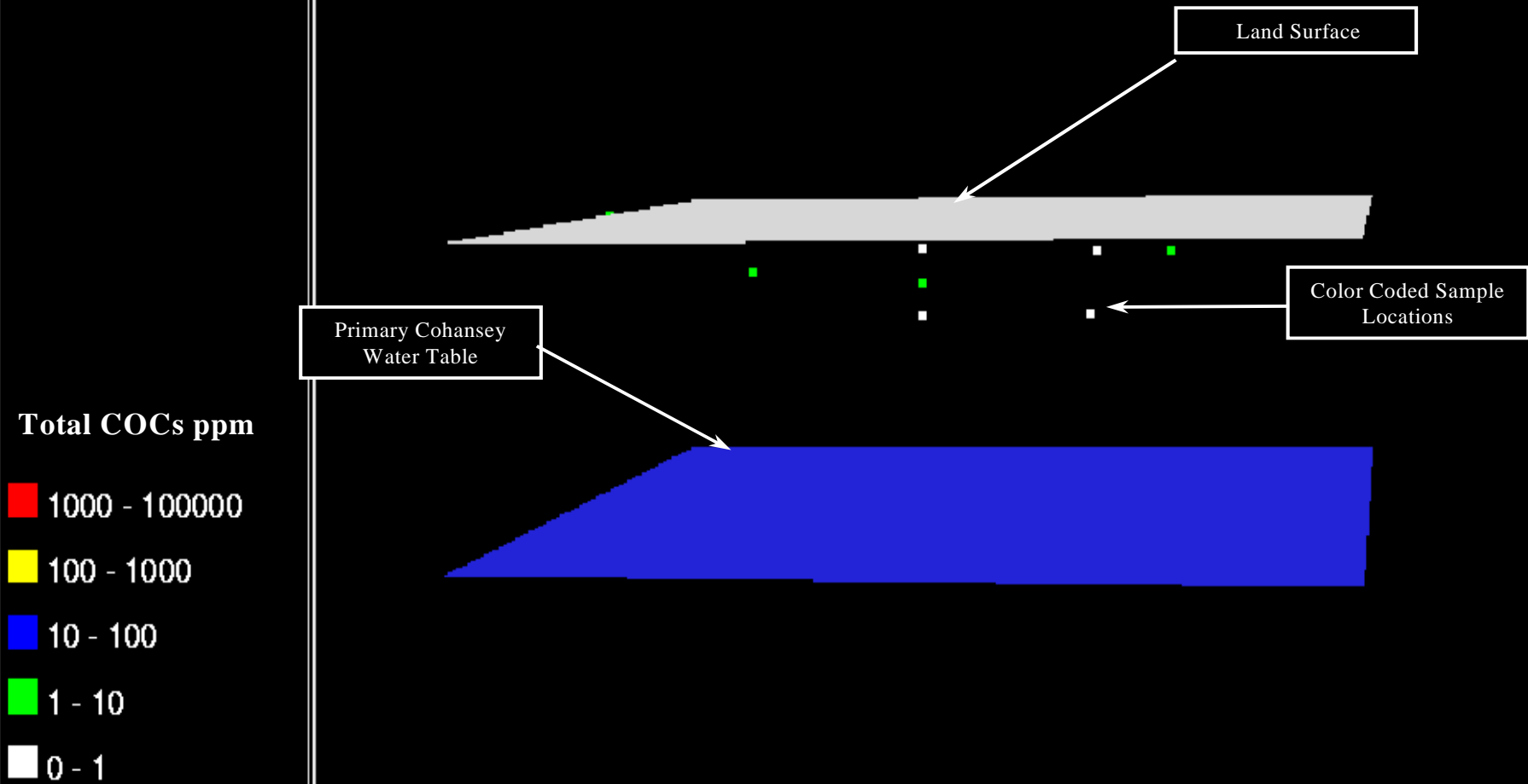
Mean = Arithmetic average concentration

50th = For the data set, 50% of values were below and 50% of the values were above this concentration

70th = For the data set, 70% of values were below and 30% of the values were above this concentration

95th = For the data set, 95% of values were below and 5% of the values were above this concentration

Figure 3-63
Calcium Sulfate Disposal Area
Color Coded Sample Locations



CSD_all_sam

3.4.3.12 Casual Dumping Area

3.4.3.12.1 Conceptual Model

Figure 3-64 presents the conceptual model for the Casual Dumping Area. The conceptual model depicts the local geology, local hydrogeology and contaminant distribution in the subsurface (i.e., location of contamination with respect to water table and geological layers). The plan view location and disposal history of the Casual Dumping Area was presented in Section 2.2.5.7.

The Cohansey Yellow Clay Member occurs beneath a small portion of the Casual Dumping Area in the northwestern portion at an approximate depth of 30 feet BLS. The presence of COCs are limited to the unsaturated zone. The CDA is another area in which COCs have only been detected at the very lowest of concentrations.

The regional groundwater table of the Primary Cohansey occurs at depths ranging from 30 feet BLS in the western portion to 35 feet BLS in the eastern portion of the source area. COC contamination does not extend into the Primary Cohansey in this area.

The top of the Cohansey/Kirkwood Transition Member occurs at an approximate depth of 70 to 75 feet BLS beneath this source area. The Cohansey/Kirkwood Transition Member separates the Primary Cohansey groundwater from lower water-bearing geological units.

3.4.3.12.2 Statistical Characterization

There have been 19 subsurface borings conducted in the Casual Dumping Area. A total of 30 chemical samples were analyzed to characterize the source area. A statistical summary of the sample data is presented in Table 3-13. There are approximately 2 pounds of COCs present in the Casual Dumping Area, which is comprised primarily of very low levels of 1,2,3-trichloropropane, 1,2,4-trichlorobenzene, 1,2-dichlorobenzene and nitrobenzene.

TABLE 3-13**Statistical Summary for the Casual Dumping Area**

Chemical of Concern	N	Mean (ppm)	50 th (ppm)	70 th (ppm)	95 th (ppm)
1,2,3-Trichloropropane	10	0.210	0.205(nd)	0.215(nd)	0.231
1,2,4-Trichlorobenzene	33	0.155	0.170(nd)	0.182(nd)	0.365(nd)
1,2- Dichlorobenzene	33	0.161	0.170(nd)	0.182(nd)	0.365(nd)
2-Chlorotoluene	10	0.102	0.048(nd)	0.050(nd)	0.349
Chlorobenzene	33	0.025	0.005(nd)	0.026(nd)	0.079(nd)
Naphthalene	33	0.156	0.170(nd)	0.182(nd)	0.365(nd)
Nitrobenzene	33	0.155	0.170(nd)	0.182(nd)	0.365(nd)
Tetrachloroethene	33	0.017	0.005(nd)	0.023(nd)	0.049(nd)
Trichloroethene	33	0.021	0.005(nd)	0.028(nd)	0.063(nd)

Notes:

N = Number of samples

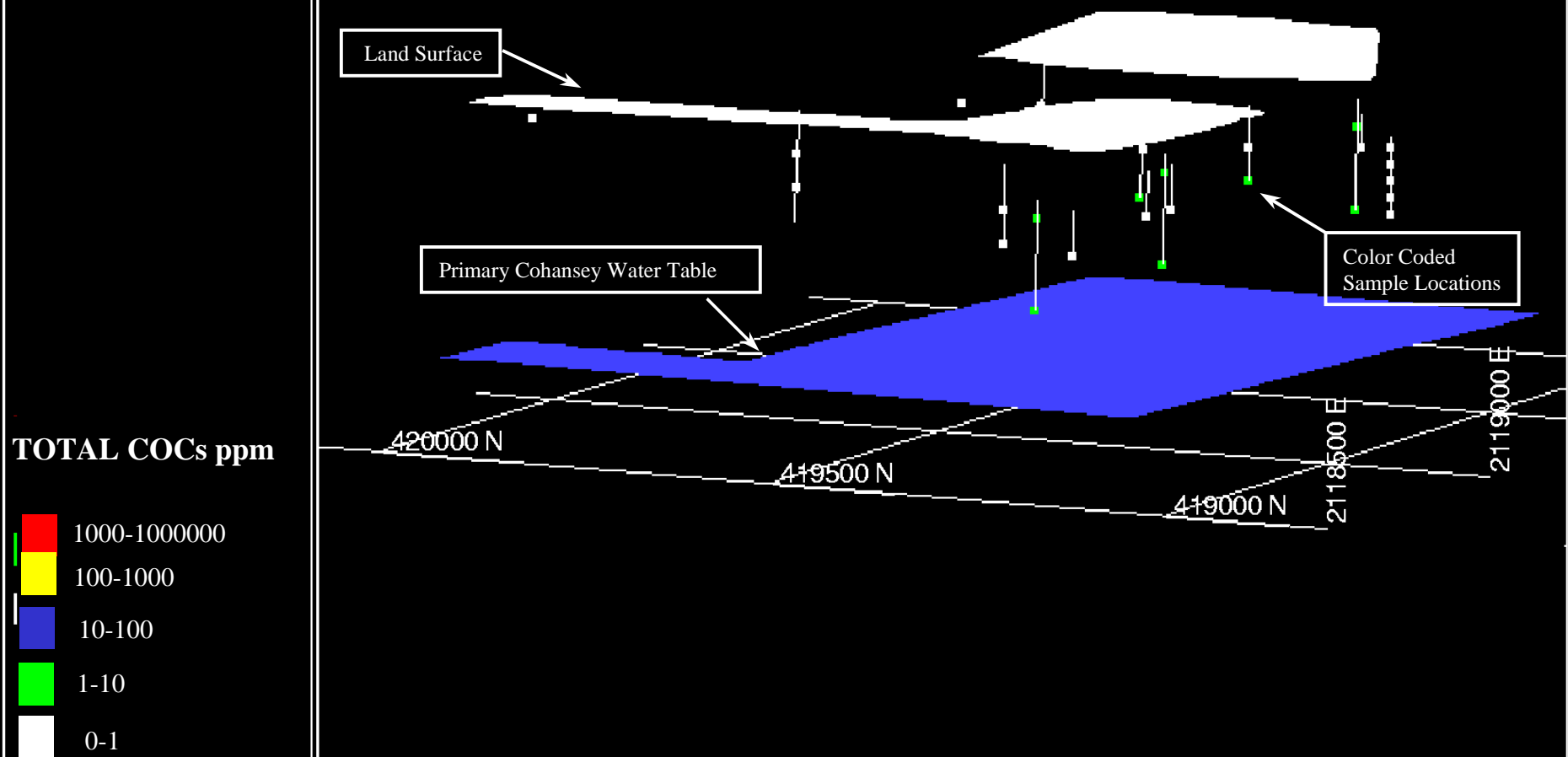
Mean = Arithmetic average concentration

50th = For the data set, 50% of values were below and 50% of the values were above this concentration

70th = For the data set, 70% of values were below and 30% of the values were above this concentration

95th = For the data set, 95% of values were below and 5% of the values were above this concentration

Figure 3-64
Casual Dumping Area
Color Coded Sample Locations



cda_saml.ps

3.4.3.13 Fire Prevention Training Area

3.4.3.13.1 Conceptual Model

Figure 3-65 presents the conceptual model for the Fire Prevention Training Area. The conceptual model depicts the local geology, local hydrogeology and contaminant distribution in the subsurface (i.e., location of contamination with respect to water table and geological layers). The plan view location and historical activities associated with the Fire Prevention Training Area was presented in Section 2.2.6.2.

The Cohansey Yellow Clay Member is absent beneath the Fire Training Prevention Area, so no perched groundwater exists. The source area is located immediately adjacent to the Toms River and a large meander occurs in the river channel in this vicinity. COCs are present in the unsaturated zone in very low concentrations.

The regional groundwater table of the Primary Cohansey occurs at an approximate depth of 23 to 24 feet BLS. COC contamination does not extend into the Primary Cohansey beneath this area.

The top of the Cohansey/Kirkwood Transition Member occurs at an approximate depth of 40 to 45 feet BLS beneath this source area. The Cohansey/Kirkwood Transition Member separates the Primary Cohansey groundwater from lower water-bearing geological units.

3.4.3.13.2 Statistical Characterization

There have been 13 subsurface borings conducted in the Fire Prevention Training Area. A total of 31 chemical samples were analyzed to characterize this source area.

A statistical summary of the sample data is presented in Table 3-14. There are approximately 3 pounds of COCs present in the Fire Prevention Training Area. The primary COCs are 1,2,4-trichlorobenzene, 1,2-dichlorobenzene and naphthalene.

TABLE 3-14**Statistical Summary for the Fire Training Prevention Area**

Chemical	N	Mean (ppm)	50th (ppm)	70th (ppm)	95th (ppm)
1,2,3-Trichloropropane	11	0.225	0.225(nd)	0.228(nd)	0.246(nd)
1,2,4-Trichlorobenzene	29	0.293	0.170(nd)	0.175(nd)	0.380(nd)
1,2- Dichlorobenzene	29	0.221	0.170(nd)	0.175(nd)	0.210
2-Chlorotoluene	11	0.050	0.052(nd)	0.053(nd)	0.057(nd)
Chlorobenzene	29	0.033	0.003(nd)	0.076(nd)	0.085(nd)
Naphthalene	29	0.218	0.170(nd)	0.175(nd)	0.210(nd)
Nitrobenzene	29	0.222	0.170(nd)	0.175(nd)	0.210(nd)
Tetrachloroethene	29	0.022	0.004(nd)	0.046(nd)	0.052(nd)
Trichloroethene	29	0.027	0.003(nd)	0.060(nd)	0.067(nd)

Notes:

N = Number of samples

Mean = Arithmetic average concentration

50th = For the data set, 50% of values were below and 50% of the values were above this concentration

70th = For the data set, 70% of values were below and 30% of the values were above this concentration

95th = For the data set, 95% of values were below and 5% of the values were above this concentration

Figure 3-65
Fire Training Prevention Area
Color Coded Sample Locations

TOTAL COCs ppm

1000 - 100000

100 - 1000

10 - 100

1 - 10

0 - 1

